THE

ELECTRICAL REVIEW.

VOL. XLI. JULY 16, 1897. No. 1,025.

CONTENTS:

	PAGE
The Engineer's Strike	71
Third-Rail Electrical Equipment of New York, New Haven and Hartford Railway (*illustrated*) (*continued*)	72
The Marconi System of Telegraphy (*illustrated*)	73
Electric Power Transmission at Fresno, California (*illustrated*)	76
The Temperature of Flue Gases	79
Correspondence:—Colonial Electric Lighting	80
Cardew Earthing Devices	80
Alternating Arcs	80
Electric Pumping—South Staffordshire Mines Drainage ...	80
Induction through Sea-Water	81
The Engineer's Strike	81
Legal:—The Metropolitan Electric Supply Company *v.* Samuel Wheeler	81
Cackett *v.* Dickenson	81
Torkington *v.* Hughes	81
Blackburn *v.* Harrison & Son	81
Business Notices, &c.	82
Electric Lighting Notes	83
Electric Traction and Motive Power Notes	84
Telegraph and Telephone Notes	85
Contracts Open and Closed	86
Electricity Meters	86
Notes	87
City Notes	90
Traffic Receipts	92
Share List of Electrical Companies	93
Recent Progress in Arc Lighting	94
The Municipal Electric Association (*illustrated*) (*continued*) ...	95
Technical Education in Germany	99
Single-Phase Motor Insulation	100
New Patents and Abstracts of Published Specifications	100

THE
UNIVERSAL ELECTRICAL DIRECTORY
(J. A. BERLY'S).

PRICE 6/- POST FREE.
The Leading Electrical Trades Directory and the Oldest Electrical Directory in the World.

1897.

PRICE 6/- POST FREE.
Fully Revised and Thoroughly Reliable.
Contains a larger amount of Trade Matter than any other Electrical Directory

H. ALABASTER, GATEHOUSE & CO.,
22, Paternoster Row, London, E.C.

THE ELECTRICAL REVIEW.
Published every FRIDAY, Price 4d.
The Oldest Weekly Electrical Paper. Established 1872.
TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—22, PATERNOSTER ROW, LONDON.

Telegraphic Address: "AGREKAY, LONDON." Code A B C. Telephone No.
ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.
ADVERTISEMENT RATES ON APPLICATION.
The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free per Year, 19s. 6d. To *all other countries*, per Year, £1 4s.
BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.
CASES,—Cloth Cases for Binding can be had, price 2s. 6d. each.
READING CASES, to hold from One to Twenty-six Numbers until the Volume is complete for Binding, can now be had from the Publishers, Price 6s. or Free by Post (in Great Britain), 6s. 6d.
FOREIGN AGENTS.—New York: D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 22, Rue de la Banque. *Berlin* ASHER & Co., 5, Unter den Linden.
Cheques and Postal Orders (on Chief Office, London) to be made payable to Mr. H. ALABASTER, 22, Paternoster Row, E.C.

THE ENGINEERS' STRIKE.

To some minds, a great deal of quite unnecessary fuss is being made over the question of 8 hours. An employer remarked recently that he would be exceedingly glad to put all his hands on the six hours' system, if he could get six hours decent work out of them. The trouble with men, nowadays, is not how long, or how short, hours they want to work, but the amount of work they are willing to do in the few short hours during which they profess to labour. Many complaints have reached us as to the absolute laziness of the men, and in our inquiries into the matter we have been able to find evidence of the plentiful supply of so-called workmen whose object in life during the recent busy time seems to have been to go from shop to shop doing simply nothing. They are put up with for a day or two, and then discharged, and away they go to another factory to carry on the same tactics. The men who really are hard-working are paying thousands of pounds to find these fellows an easy, idle living.

We feel confident from what we hear that the trouble with the engineering business is one of work not of hours. The Union, however, are acting in a thoroughly wrong spirit. They claim that 8 hours is enough for a day's work and deprecate overtime. In both these we will not at the moment oppose their contention. They say if only 8 hours is worked there will be room for more men—now idle. Now this is a palpable absurdity. There is not, or was not before the trouble, any man in London out of work unwillingly who was worth 3d. per hour as a smith or machinist. Men have been obtainable it is true, but when put to work they have not shown themselves to be worth even a penny an hour. Yet these are the men that the Trades Union demand shall be paid nearly 1s. an hour.

The secretary of the Amalgamated Society of Engineers in his last report stated that it was their intention to compel payment of high wages to anyone who minds a machine, no matter how little skill may be required for the work. This is absolute folly. Machine minding is work that in all manufacturing shops can be done by any labourer, and he can often look after several machines. In America this is the case. One man looks after a lot of machines just as in the manufacturing districts one girl will tend several looms. The A.S.E. cannot see that any legitimate means of cheapening production must help business in the long run. As things now are, the cheapness and excellence of many things from America is forcing them upon us to the exclusion of English made productions.

Recently in the north of England we were shown some special fittings which bore no trace of their origin, but which we at once recognised to be of foreign make, and we assert without hesitation that these articles could be more cheaply made at home by English workmen if they would only put in an honest six hours' work per day.

At present the workman proceeds so slowly at his work that he can hardly go more slowly, and to reduce his hours some 12 per cent. means an actual reduction of output. From the tone and bearing of the A.S.E., we may take it they do not intend to urge their members to do a fair day's work. They rather mean to encourage laziness, so as to make room for more men, who are not even in existence, to be employed. There can be no doubt that lately the engineering trade has been brisk, and this seems to have been the incentive to the latest move—a move which we believe to be exceedingly unpopular with large numbers of the men themselves, who, however, feel themselves to be powerless in the hands of their officials, who once appointed, hang, like the old man of the sea, round the necks of the men. We think that had the Union first put themselves right in the eyes of all right thinking men by purging their ranks of the morally blind, halt and maimed, and enforced on their members the moral obligation of a fair day's work for fair wages, they could without difficulty have readily secured an eight hours' day. It is exceedingly rare, and then it only happens through stress of circumstances, that the weekly pay day does not find the masters ready to pay the week's wages, and how nimbly the Union's lambs trot across the yard to the treasury. Do they ever reflect that they have not earned a quarter of what they draw? We would not include every man in this sweeping condemnation, for in the course of our inquiries we have found instances just the reverse.

Our contemporary, the *Practical Engineer*, very sensibly suggests that it would be far wiser for the A.S.E. to help their foreign co-workers nearer to the English status. Were this done, there might be sense in a further step here. But the A.S.E. cares for none of these things. All it asks is a high wage; all it offers is half-hearted and slovenly service.

In a sense the A.S.E. is true to its practice, for it appears to be of opinion that it is undesirable that England should continue to maintain its supremacy in manufacturing, and certainly the Society is doing a great deal to put an end to this supremacy, not merely in asking for an 8 hours' day with 9 hours' pay, but in its policy of harassing the employers. The cost of an article is chiefly made up of wages, and American productions are made by workers who, in comparison with this country, appear to be earning high wages. Their living wage is bound to be high, because the cost of living is so very great. In purchasing power the English wages are much higher than American wages, yet the amount of work done is less. Did the English worker choose, he could do as much in 8 hours as the American with inferior physique, and most trying and arduous climate, can do in his longer hours. An English turner, for example, could easily attend to several lathes on certain classes of work. The American does this, and in America the mere child's play of putting work to an automatic machine is given to labourers at good labourers' pay, where in England the Union compels the services of a high priced man. We would not quarrel with the 8 hours' day in face of even the few facts in its favour, such as for instance, the experiences of Mather & Platt, which, however, did not go so far as to give more pay for less labour; but we do think it monstrous that 9 hours' full pay and 8 hours' engine power should be expended upon a lot of men who make no effort to do even a real day's work in a week.

Cable Recorders. THE new cable recorder of M. Ader makes many claims upon our attention; facility of reading its indications is not the least of its advantages. Anyone who has experienced the difficulties of deciphering recorder slip, following the trail of a nervous, sinuous line through all its wriggling hesitancies, will greet the photographic method cheerfully, as an old idea of great promise. Far be it from us to spread discontent among mirror-clerks, but we appeal to instrument makers: "spot-watching" is an irrational occupation, terribly injurious to the eyes, can you not do something better? Notwithstanding the pages of learned matter that have been written during the past 10 years, *apropos* of improved speeds in submarine telegraphy, very little progress has been made, except perhaps in the mechanism of the transmitter. The automatic transmitter is now almost perfect of its kind; we are in a position to transmit at the rate of 1,000 or 2,000 words per minute. But, unfortunately, these signals never get there. Neither cable nor receiver can cope with them. Awaiting, then, the advent of a high-speed cable, or a fast-speed no-cable-at-all, it would seem that time might well be spent in improving the legibility of signals, and we are inclined to think that there is no more promising way of doing this than by photography. This gentle art has revolutionised the methods of astronomy, and almost every other science, craft, and trade dependent upon records; some attempt has been made to apply it to the purpose of immortalising the readings of ammeters and voltmeters, but electricians have not yet fully appreciated its merits, nor realised its simplicity. From the scanty descriptions given in the French journals, it is somewhat difficult to pre-judge the receiver of M. Ader except on this one point of the successful adoption of photography to such instruments. A very fine wire is stretched across the field of a powerful permanent magnet at right angles to the maximum flux. At each current-impulse through the stretched wire, the wire is sagged to right or left, depending upon the direction of the current. At the middle of the wire a small piece of pith is attached, and below this runs the sensitised paper slip. A narrow beam of light is directed transversely to the paper, in front of the pith, so that the motions of the wire are recorded on the slip as a sinuous line. The development and fixing is done *en passant*. This apparatus is claimed to be more sensitive than any preceding instrument, whether siphon-recorder or mirror. It has been tried on the trans-Atlantic cable between Brest and St. Pierre, and upon the Marseille-Alger cable, with the result that upon the first cable it gave, with facility, 600 signals per minute, as against 400 on the old recorder, and through the second cable 1,600 signals per minute were transmitted, as against a previous 600. It may turn out that the sinuous line on the sensitised paper is more troublesome to read than the siphon-recorder line, but it is scarcely likely. The absence of the friction between the siphon and the paper, and the small inertia of the moving parts, are advantages that ought to be brought to account on the score of legibility.

Leakage. A PAPER communicated to the Royal Society of Edinburgh by Lord Kelvin and Dr. Magnus Maclean forms the second part of an investigation with regard to leakage from electrified metal plates and points, placed above or below uninsulated flames. It is proved experimentally that the leakage between two copper plates, each 10 square centimetres in area, separated by 1 cm., when the fumes from a Bunsen burner pass between them and round them, is approximately proportional to their difference of potential so long as that difference is above 20 volts. The proportionality has been tried by the authors up to 94 volts. Below 20 the leakage diminishes with

decreasing voltages at a greater rate than simple proportion. It was observed years ago by Priestley that the discharging property of a flame is not limited to the region above the burner; the ascending currents of air at the side of, or even below, the flame possess this quality. But the authors now show that the degree of discharge, 5 cms. above a flame, is enormously greater than at 5 cms. below it. Comparing the disinsulating power of flames with respect to metal points and discs, it is found that for the same distance between the flame and either the point or the disc, the rate of leakage corresponding to a given difference of potential, is *less* for the point than for the disc. Thus with a flame 25 cms. above a metal point, the time of drop from 3,000 to 2,000 volts is 1′ 53″; and with the same flame at a similar distance above the horizontal plane of a metal disc, 8 cms. in diameter, the time of drop through the same difference of potential is 1′ 14″. This is a very important result. Further experiments relate to the effect of interposing non-conducting plates of glass, paraffin, and mica, between the point or disc and the flame; the authors hope to determine, by special experiment, how much of the fall of potential is due to the electricity of opposite kind induced on the uppermost surface of the non-conducting plate, and how much, if any, is due to leakage through the air to the metal disc or point below. We are rather surprised to come across the statement that a continuation of these experiments is deferred "until the insulation of the electrometer is made practically perfect by coating its vulcanite insulators with paraffin." As a general rule the use of paraffin for such a purpose is a mistake; it seems to be forgotten that paraffin absorbs moisture like a sponge, and however perfect the insulation may be when the wax is first applied, it rapidly deteriorates. Would it not be better to apply a "guard-wire," as suggested by Mr. W. A. Price? This latter method is described in the *Phil. Mag.*, for August, 1896, p. 150, and in the Electrical Review, Vol. xxxvii., p. 702.

Some Superheating Figures.

Some Bavarian tests on a Sulzer engine, abstracted by the Inst. C.E., show that the daily supply of cylinder oil found necessary in a compound engine was 4·3 lbs. with superheated steam, as against 3·8 lbs. when using saturated steam; but after five months working with steam at 220° to 230° C. the cylinder was in good order and also the rods. The oil used was also of better quality when the superheat was raised to 260° C., and had a flash point of 320° C. and ignition point 350° C. Since the tests the engine has even been worked at 270° to 290° {518° F. to 554° F.}, and Austrian engineers claim to work up to 350° C. without injury or structural alteration when the lubricant is good. The feed-water consumed when using saturated steam was 19 lbs. This fell to 15·6 lbs. with moderate (252° C.) superheating, and to 14·1 lbs. with higher superheat (292° C.). A superheat of 65° C. saved 17 per cent. of steam, and a superheat of 96° C. saved 26 per cent. Part of the gain is probably correctly attributed to the drying of steam previously wet. This, of course, is one of the advantages of superheat. Superheated steam must be at least dry. Saturated steam may be anything. The higher superheat showed 9 per cent. economy of steam, and 7 per cent. coal economy over the lower superheat. At moderate degrees of superheat the steam saved was almost balanced by the fuel burned in the separate superheater. Experience generally is we think scarcely favourable to the separately fired superheater, but all properly conducted tests show that as regards the engine the economy of superheat is unmistakable. They also point to necessity of using pipes as short as possible with superheated steam. The specific heat of steam is so small and the value of a little heat so great, that long pipes soon cause a serious fall in temperature. All evidence so far points the value of a little superheat, and shows that the results which accrue are quite out of proportion to the small additional amount of heat.

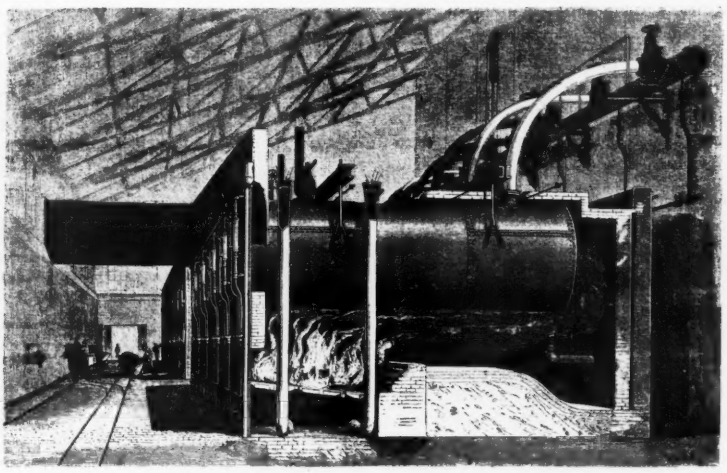
The Refractive Index and Reflecting Power of Water and Alcohol for Electrical Waves.

The electro-magnetic theory of light, as originally given by Maxwell, included only the optics of a single wave-length, and required extension to justify and harmonise the facts of selective absorption and dispersion. This extension was made by Helmholtz. According to him, a change in the refractive index with the wave-length is to be expected throughout the complete spectrum; but, beyond a certain wave-length, these values approximate rapidly to a fixed limiting value, so that the index may be regarded as practically constant for longer waves. The period of this characteristic wave-length is theoretically of the same magnitude as that of the slowest possible vibration of the molecule, but it is practically unknown. Yet recent researches render it probable that this close approximation to a constant limiting value is exhibited by wave-lengths much smaller than all electrical waves thus far produced. H. Rubens has shown (*Wiedermann's Annalen*, 42, p. 581, 1891) that several substances which fail to satisfy the fundamental relation of Maxwell, $\mu^2 = K$ (where μ is the refractive index and K the dielectric constant of the substance), for light waves, do fulfil it for radiations in the same infra-red only a little below the visible spectrum. For some other substances—rosin oil, olive oil, and certain kinds of glass—Arons and Rubens (Arons and Rubens, *Wiedermann's Annalen*, 42, p. 581, 1891) have shown that this relation is satisfied with electrical oscillations of 6 metres wave length, although not with light waves. E. Cohn (E. Cohn, *Wiedermann's Annalen*, 45, p. 370, 1892), has further shown that even with water, whose refractive index for light differs so much from the square root of the dielectric constant, the index for long electrical waves conforms to the law of Maxwell. By entirely different methods, Ellinger (Ellinger, *Wiedermann's Annalen*, 46, p. 513, 1892), and Udny Yule (Udny Yule, *Wiedermann's Annalen*, 50, p. 742, 1893), have reached similar results. It seems probable that the great change in the value of the refractive index shown by these substances occurs in a part of the spectrum much nearer light waves than the Hertz oscillations. Still, the researches of Gratz and Fomm (Gratz and Fomm, *Wiedermann's Annalen*, 54, p. 626, 1895), and of Drude (P. Drude, *Wiedermann's Annalen*, 54, p. 352, 1895), indicate a certain amount of dispersion, even for long electrical waves. It seemed desirable, therefore, to investigate the refractive index of these substances, particularly of water and alcohol, to see if it is the same for very short electrical waves as for long ones. The work was consequently undertaken by A. D. Cole in Prof. Warburg's laboratory, and partly under the guidance of Dr. Rubens, of the Berlin University. The paper describing the investigation is given in full in *Wiedermann's Annalen der Physik und Chemie*, 1896, Vol. 57, p. 290; but this notice of it is made up from the author's translation in *Technology Quarterly*, Vol. iv., p. 50. It will scarcely suit our purpose to follow the author through the details of his work, and his minute description of the apparatus employed, we therefore simply notice that he investigates (1) the velocity of long electrical waves in water and alcohol by the method of E. Cohn. (2) Refractive index for short electrical oscillations. (3) Reflecting power of a metal for electrical waves. (4) Reflection of electrical oscillations by liquid surfaces. The paper is illustrated by diagrams of the apparatus employed and by tables. Summarising all the results, we find that (1) For oscillations of 300 cm. to 600 cm. total wave-length, the refractive index for water is 8·95, for alcohol 5·20. (2) For oscillations of 5 cm. wave-length two Fresnel formulas give the same value for the refractive index from observations of energy reflected at 45°. For water this value is 8·85, for alcohol 3·2. (3) The refractive index of alcohol is decidedly greater for long than for short electrical oscillations. Clearly the research is not yet concluded. Difficulty was experienced in constructing suitable apparatus, and time was lacking. We understand, however, that the work will be resumed shortly.

THIRD-RAIL ELECTRICAL EQUIPMENT OF THE NEW YORK, NEW HAVEN, AND HARTFORD RAILROAD.*

(*Concluded from page* 37.)

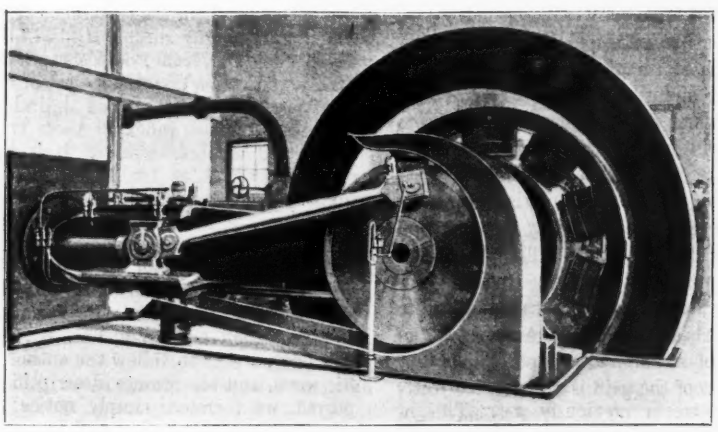
In our previous notice of the electrical equipment of a portion of the lines of the New York, New Haven, and Hartford Railroad, we stated that the power-house at Berlin was a plain rectangular structure 106 feet in width × 117 feet long, the sides and one end being of brick, the other end being temporarily boarded up until the building shall be extended and completed. The building is divided longitudinally by a brick partition wall; the front portion, or that facing the tracks, is two stories in height, the engines and dynamos being installed in the upper story, and the heaters and various accessories in the basement. The rear half constitutes the boiler room.



Boiler House.

At present the engine room contains a 1,200 horse-power engine of the cross compound type, with a 28 inch × 48 inch high pressure cylinder, and a 48 inch × 48 inch low pressure cylinder. The fly-wheel is 18 feet in diameter, and weighs over 52 tons. The engine dynamo shaft is of hollow steel, and the engine is direct connected to a General Electric Company's standard 10-pole 850-kilowatt generator of the ironclad type.

The switchboard is set in a bay built out on the front of the building. It is of the standard panel type of the General Electric Company, and contains seven panels, of which three only are at present equipped. Two of these are generating panels, and the third is a totalising panel. Upon the former are automatic circuit breakers of extra large size, with magnetic blow-out, and the usual generator panel equipment; the totalising panel carries a form G Thompson 5,000 ampere recording wattmeter, and an 8,000 ampere station ammeter. Four cables, each of 850,000 circular mils. cross section, run from the switchboard to the third rail.



1,200 H.P. Cross Compound Engine.

The boiler room contains 10 horizontal tubular boilers, which type has been selected on account of its "simplicity, high economy, and general reliability." In setting the boilers, care has been taken to provide for absolutely free expansion in all directions, and especially in a direction transverse to the axis of the boilers. It will be seen from the illustration that the boilers are suspended from two pairs of I beams, which rest upon the brick partition walls, the suspension rods being linked to straps which are riveted to the shell of the boiler. The great height (48 inches) from the fire bars to the boiler is a noticeable feature, and it was adopted in order to secure a more thorough combustion and a slower passage of the gases to the uptake. It is claimed that with judicious firing the uptake temperature has been kept considerably below the normal for this type of boiler. The grates are designed for burning the half burned coal known as "sparks," which is recovered from the fire boxes of the locomotives of the New Haven road. As there are several hundred tons of this material produced every month, it can be understood that it is an extremely cheap fuel as delivered in the bins at the power house. The pipes which lead down through the partition walls and below the grate are for introducing a mixture of steam and air to supply the necessary oxygen for combustion. Each pipe is slightly flaring at the top, and contains an annular steam pipe perforated on its under side. The gases pass from the boiler tubes to a rectangular flue, which extends the full length of the nest of boilers, and delivers into a cross flue 5½ feet wide by 8 feet deep, which leads to a chimney 125 feet in height on the outside of the building. The "sparks" is delivered into a row of bins located on the outside of the boiler house, and from these it is drawn off as required into small trucks, which run on a track parallel with the wall of the building. From this track it is switched on to another track, which runs at a convenient distance from the furnaces. The fuel is shovelled directly from the trucks into the furnace. Swinging trucks are also provided for carrying away the ashes. Special care has been taken in designing the boiler fronts, which are held in place by clamps, and may be taken down separately in a few minutes by loosening the clamps—an arrangement which will commend itself to practical men at first sight.

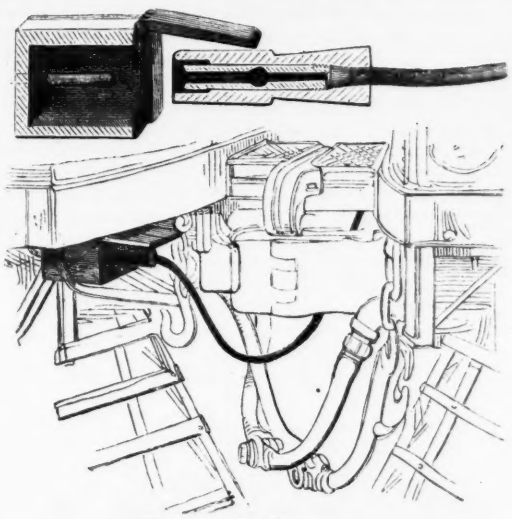
Another point which has received special attention is the arrangement of the steam piping. Col. Heft does not believe that it is good policy to put in a costly duplicate system of piping, and he is of the opinion that satisfactory results may be obtained by exercising care and good judgment in the design and erection of a single system. Accordingly, every provision has been made for the free movement of the piping under expansion and contraction. In the first place, a 20 inch wrought-iron header runs the entire length of the boiler room, at a height of 8 feet above the boilers.

* *Scientific American.*

It has a free longitudinal movement upon rollers, which are carried upon brackets attached to the central partition wall of the building. Each boiler is connected with the header by a heavy seamless copper 9-inch pipe bent to a radius of 8½ feet. The throttle valves are placed at the junction of these pipes with the header, the valves being all of the balanced type. Steam is led to the engine by 12-inch wrought-iron pipes with bends of large radius. The piping of the accessory steam plant is so arranged that the engines may be run as condensing or non-condensing. Each side of the engine can be run independently, and the feed may or may not be heated, at the option of the engineer.

In the illustration showing the various car couplings will be noticed the electrical car coupling or connector box. In the earlier experiments considerable trouble was experienced at the exposed point where the wires entered the motors, and the connector box was designed to overcome the difficulty. The connection consists of a hollow brass tube, split at the outer end to give it a tight grip of the motor wire, and incased in a wooden plug. There are two of these, and they enter a connector box located beneath the front end of the platform, as shown in the engraving, the box being closed by a lid when it is not in use.

The closed cars are each provided with 16 electrical heaters, which are placed beneath the seats. The degree of current, and therefore the temperature, is regulated by means of an electrical switch of special construction. There are



Electric Car Coupling.

four graduations on the dial: full, half, low, and off. The dial, which is movable, has the brushes attached to its inner face, and these move upon a series of contacts on the fixed plate. In order to reduce the spark on opening or closing the switch, the switch lever is formed separately from the knife, the former being hinged to the latter near its junction with the switchboard. Normally the knife is held against the lever by the tension of a plate spring; but when the lever is pulled open the two are separated, the knife snapping suddenly against the lever as it leaves the contacts and reducing the duration of the spark.

The heaters in each coach are connected in series with each other, and form a complete circuit extending down on one side of the car and up on the other, in which all of the 16 heaters are included. This circuit, known as the series wire, has no connection with the heat-regulating switch, neither is the positive (trolley) nor the negative (ground) side of the current supply permanently connected to any portion of this circuit. A variable ground and trolley connection is carried by the regulating switch, and can be applied, by means of tap wires, to one or more points of the series wire or circuit, according to the amount of heat required. As the heat generated is directly proportionate to the amount of current flowing through the wires of each heater, and as this flow of current is governed by the combined resistance of the heaters through which the current must flow, it is but necessary to vary the number of heaters between a point where the current enters and where it leaves again, in order to regulate the temperature to any desired degree.

THE MARCONI SYSTEM OF TELEGRAPHY.

We are now able to publish the following additional particulars about the apparatus used by Marconi in his system of telegraphy by electric waves.

Marconi's transmitter is shown diagrammatically in fig. 1. Two metallic spheres, G and H, placed sufficiently close together to allow short sparks to pass between them are con-

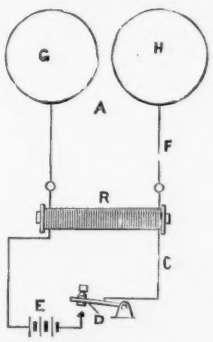


Fig. 1.

nected to the terminals of the secondary of an induction coil, R. The primary circuit, C, (fitted with the usual contact breaker) of the coil contains a battery, E, and a make and break key, D. When the break, D, is closed a stream of sparks pass between the spheres, G and H, and produce in the well-known way discovered and explained by Hertz a series of electro-magnetic waves which radiate outwards in every direction from between the spheres. By closing the circuit, C, for longer or shorter times, dot and dash signals can evidently be transmitted to any receiving instrument capable of detecting the presence of Hertzian waves.

The Marconi receiver is a sort of combination of the resonant oscillator of Hertz and Branly's coherer. It is shown diagrammatically in fig. 2. Two metal plates, M, N, are made of such a length, that the natural rate of oscillation

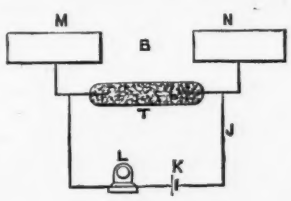


Fig. 2.

of a displaced electric charge on their surfaces synchronises with the frequency of the Hertzian waves generated by the transmitter. In a shunt circuit, J, connected to the terminals of the coherer, are placed a voltaic cell, K, and any ordinary telegraph receiving instrument, L. Now, when the Hertzian waves strike the oscillator, M, N, the electric waves produced therein cause the filings in the coherer tube, T, to conduct, and the battery, K, is thereby enabled to generate a current in the circuit, J, which actuates the telegraph receiving instrument, L. Considerable modifications have to be made in these ideal transmitters and receivers in actual practice. These will be best understood from a detailed description of the instruments themselves.

The transmitter is shown in fig. 3. Two pairs of polished brass or copper balls, d, d, and e, e, are supported in ebonite brackets d^1, d^1, and e^1, e^1. The distance apart of the brackets, e^1, e^1, can be adjusted by two bolts, e^2, e^2, by screwing up or unscrewing their nuts. A piece of parchment is wrapped round the two balls, e, e, so as to enclose a space between the two balls and form a kind of vessel which is filled with vaseline. The insulating liquid between the spheres has been found to increase the power of radiation, and also enables more uniform effects to be obtained. The balls, d, d, e, e, are of solid brass or copper. The distance between d and e depends on the E.M.F. used in working the apparatus. The effect increases with the distance between d and e, so long as the discharge passes freely. With an

induction coil giving an 8-inch spark, the distance between d and e should be about 1 inch, and the distance between e and e about $\frac{1}{25}$th to $\frac{1}{30}$th of an inch. The size of the balls has also an important influence on the distance to which signals can be transmitted; *cæteris paribus* the larger the balls, the greater is the possible distance of transmission. A cylindrical parabolic reflector, placed so as to have the balls, e, e, in its focus, may be used to direct a beam of the rays in a definite direction. When a reflector is not used, the waves, of course, radiate in every direction.

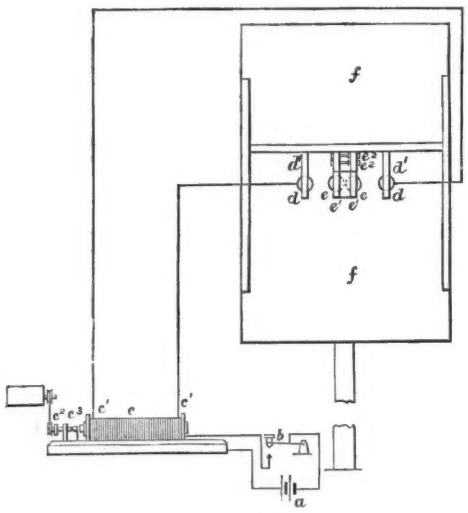


Fig. 3.

The arrangement of the circuits of the transmitter will be readily understood by comparing fig. 3 with the ideal transmitter in fig. 1. The terminals, c^1, c^1, of the secondary circuit of the induction coil, C, are connected to the outer balls, d, d. The primary circuit contains a battery, a, and a make and break key, b. It is necessary to use a good automatic break for the coil. The mercury break may be used, or any other of the usual forms. In the form illustrated in the figure, the platinum contact point is rotated rapidly by a small electromotor. There appears to be some difficulty in getting a break which will produce a perfectly uniform discharge of sparks from the secondary of an induction coil. Hertz preferred the mercury break in his experiments, and no doubt that will be found to be the best in this case also. Hertz also found that the best effects were obtained by the use of a large induction—about 18 inches in length—in his experiments.

To facilitate focussing, the two inner balls, e, e, may be made hemispherical, with small projections in the centre to determine the passage of the spark. The space between the two hemispheres is filled with insulating oil. Fig. 4 illus-

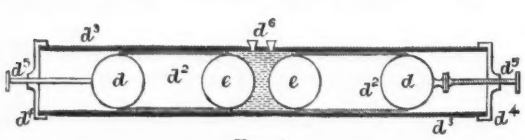


Fig. 4.

trates another method of mounting the balls, d and e, of the transmitter. Each pair of balls, d, e, is fixed in a short piece of ebonite tube, d^2, which fits telescopically in a larger piece of tube, d^3. Each ball, d, d, is connected to a rod, d^5, which serves to make connection with the external circuit, and also to adjust the distance apart of the balls, e, e. This adjustment is effected by the rod, d^5, on the right-hand side, which screws into the cap, d^4, and is connected to the ball, d, by a ball and socket joint. By turning this rod, d^5, the corresponding tube, d^2, can be moved backward or forward, and the space between the balls, e, e, thereby adjusted. The space, d^6, between the balls, e, e, is enclosed by the external tube, and forms a vessel to contain the insulating oil. This oil is filled in by one of two openings left for this purpose on the top of the tube.

When very high E.M.Fs. are used to work the transmitter, it is better to use several gaps by placing smaller balls at intervals between the larger balls.

When many obstacles intervene between the transmitter and the receiver, a transmitter of the form shown in fig. 5 is preferably used. In this apparatus one of the balls, d, is connected to earth, while the other is connected to a plate, u, suspended at a considerable distance from the ground. It

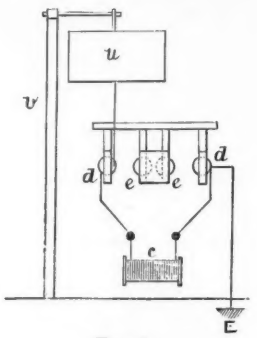


Fig. 5.

has been found that the higher the plate, u, is above the ground, the greater the distance of possible transmission. The plate, u, may therefore with advantage be suspended by a balloon or a kite at a considerable distance from the earth's surface. A cone or cylinder may be used instead of the plate, u.

A transmitter and receiver in the same neighbourhood must be screened from each other by metal plates.

Coming now to Marconi's receivers, it will be found that the deviations from previously known instruments of this type are much greater. It is necessary that these instruments should possess the extremest sensitiveness attainable, since only a very small fraction of the total radiation emitted by the transmitter impinges on the receiver. The modifications made in this instrument have been chiefly made with the view of attaining this object.

Fig. 6 is a general view of the arrangement of a Marconi receiver. The current produced in the circuit of the coherer, j, is not as a rule sufficient to work the telegraph recording

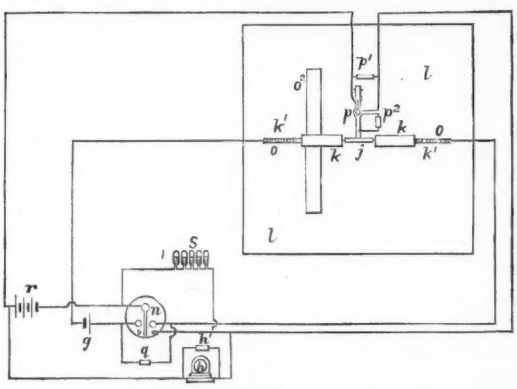


Fig. 6.

instrument, h. This difficulty is got over by the use of a relay, n. The current produced by the single cell, g, is sufficient to actuate the delicate relay, n, and close a circuit containing a battery, r, of higher E.M.F., and the recording instrument, h. This battery also supplies another circuit arranged in parallel with the circuit of the recording instrument, h. This second circuit contains a small electric hammer, p, called the "trembler." This hammer resembles the hammer of an electric bell, and is actuated in the same way, but it is rather shorter. Its function is to tap the coherer tube, j, and stop the current which has been caused to pass in it by the impact of the electric waves. For details of coherer see fig. 7. It is necessary that the sparking at the contacts of the trembler, and the consequent inductive effects should be prevented, since they would act on the coherer and restore its conductivity at

the very moment when it is desired to destroy it. This object is attained by introducing high resistance shunts, p^1 and p^2, in parallel with the trembler. The relay, n, and the recording instrument, h, are also guarded in the same way by high resistance shunts, q and h^1. When a circuit is broken, they prevent sparking and oscillations. They should be wound on the loop principle, so as to have small self-induction. The resistance of p^1 is four times that of the trembler coil, and the resistance of q is four times that of the relay. A liquid resistance, s, with a back E.M.F. of 10 volts for a battery of 15 volts is preferably used as a shunt to the relay. The cells of s are tubes containing acidulated water, into the bottoms of which a pair of platinum electrodes are fused. This liquid resistance may be replaced by a double wound platinoid resistance of not less than 20,000 ohms. Condensers may be used, but they have not been found to be so good as resistances.

Instead of tapping the tube of the coherer to destroy its conductivity, the same object may be attained by moving its electrodes slightly outwards and inwards; the trembler, in this case, being replaced by a small electro-magnet, whose armature is connected to one of the electrodes.

The receiving instrument, h, is usually worked, as we have described, by a derivation from the trembler circuit; but it may also be placed in series with the trembler. If the receiver is on a derivation, it is preferable that its resistance should be equal to that of the trembler.

The detailed construction of the coherer is shown in fig. 7. The metallic powder, j^1, is placed between two plugs, j^2, j^2, made of silver. These plugs are connected to the external circuit by platinum wires fused into the ends of the glass tube, j. The powder preferred, is a mixture of hard nickel filings and 4 per cent. of silver filings. By increasing the proportion of silver the coherer becomes more sensitive, but if it is made too sensitive it is affected by atmospheric electricity. A minute globule of mercury added to the metallic powder also increases the sensitiveness of the coherer. The quantity of mercury must not be sufficient to clog the powder. Instead of mixing mercury with the powder, the faces of the plugs may be amalgamated.

The size of the tube, j, preferred is: $1\frac{1}{2}$ inches in length, and $\frac{1}{10}$th to $\frac{1}{12}$th inch in internal diameter. The length of the silver plugs, j^2, is about $\frac{1}{6}$th of an inch, and the distance between them about $\frac{1}{30}$th of an inch. The shorter the gap the more sensitive is the coherer, but there is a certain limiting distance within which the instrument becomes unreliable. The plugs, j^2, must fit the inside of the tube exactly, as otherwise the filings might escape at the sides. The metallic powders should be coarse, and should be produced by a large rough file. The particles of the powders should be of uniform size; all very fine or very coarse particles being removed by blowing and sifting. The files used should be frequently washed and dried, and should be used when warm. The powder should be rather loose between the plugs, so that when the tube is tapped the powder may be seen to move freely. A vacuum in the tube is not essential, but it is desirable. A vacuum of $\frac{1}{1000}$th of

Fig. 8.

an atmosphere has been used. When a vacuum tube is used it must be made with a branch tube to connect on the pump.

If the tube is well made, it should be sensitive to an electric bell at a distance of 1 or 2 yards. It should also instantly interrupt the current in a non-inductive circuit containing a single cell. No more than one milliampere should be passed through the coherer, only a single Leclanché cell should be used. If a higher E.M.F. than 1·5 volts is used it is apt to pass the current through the coherer without the assistance of the inductive action of the electric waves. A tube with a number of gaps as in fig. 8 may be used. This tube may be worked with an E.M.F. equal to 1·2 volt multiplied by the number of gaps.

It is considered essential by Signor Marconi that the coherer should be tuned to obtain the advantage theoretically proved to result from electrical resonance. Marconi makes use of two metal plates, k k, fig. 7, which are connected to the terminals of the sensitive tube, and correspond to the plates, M, N, in fig. 2. The plates, k, are of copper or other metal, and are about $\frac{1}{2}$ inch in breadth, and about $\frac{1}{60}$th inch thick. The rate of oscillation of electrical charges in these plates depends on their length, and this must be determined by experiment. This is done in the following manner:—a piece of tinfoil is gummed on a sheet of glass and divided into two equal sections by cutting it across the centre with a knife. These sections are exposed to the rays from a transmitter and are lengthened or shortened till sparks pass across the gap at a considerable distance from the transmitter. The plates, k, fig. 7, should be about $\frac{1}{2}$ inch

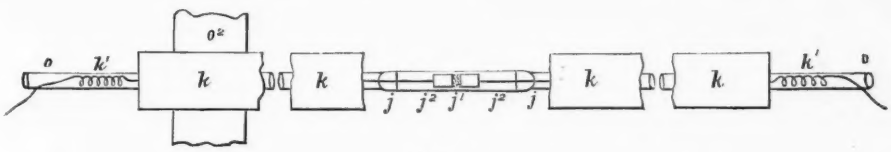


Fig. 7.

shorter than the length thus determined to allow for the length of the tube.

The plates, k, k, are fastened to a thin glass tube, o, preferably not longer than 12 inches. This tube is fixed at one end to a wooden support, o^2; or the sensitive tube may be fixed firmly at both ends.

With multiple gap tubes, the recording instrument and the trembler may be placed in the coherer circuit. The receiver may be placed in the focus of a cylindrical parabolic reflector, preferably made of copper. The detector for determining the length of the plates, k, k, should, in this case, then be tried in the focus of the reflector, since the lengths which will give the best results are somewhat different when a reflector is used. The reflector should be, in length and opening, not less than double the length of the wave omitted. The focal length is preferably $\frac{1}{4}$ to $\frac{3}{4}$ of the wave length.

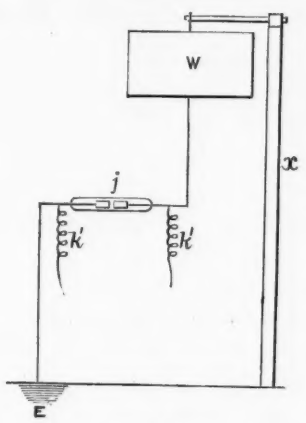


Fig. 9.

Choking coils, k^1, k^1, are used to prevent the oscillations in k, k, passing round the battery circuit.

Fig. 9 is a type of receiver resembling, in its arrangement, the transmitter shown in fig. 5. One terminal of the coherer tube, j, is connected to a metal plate, W, which is supported on a long pole, x, or on a kite or balloon, at a considerable distance from the ground. The other terminal is

connected to an earth plate, E. Choking coils, k', k', are used to prevent the waves passing into the battery circuit as in fig. 7. The most successful experiments made in telegraphing across the Bristol Channel have been made, we believe, with transmitters and receivers of this type.

ELECTRIC POWER TRANSMISSION AT FRESNO, CALIFORNIA.

The city of Fresno, California, is a thrifty young town of about 15,000 inhabitants, situated in the centre of the wide plains of the San Joaquin Valley. It has become famous as the greatest raisin producing district in America, and now has the added distinction of having the longest distance electric transmission plant operated under the highest head of any in the world. The town, being situated 200 miles from the sea board, and there being no local deposits of coal, has been hampered in its manufacturing growth by the high price of fuel, and thence the transmission of electric power from some one of the rivers has been discussed since the first successful transmission of electric power from Lauffen to Frankfort, Germany, in 1893.

During 1894 the projectors of the present San Joaquin Electric Company made thorough examinations of all possible sites for power development, and finally fixed on the North Fork of the San Joaquin River as the most feasible, owing to its peculiar advantages from an engineering point of view. While there are many places where a low head plant can be installed within a distance of from 15 to 20 miles from the town, the large outlay for hydraulic plant in developing them made them impracticable.

It was found by careful investigation that it was much simpler and cheaper to build a longer line, and to spend less money in the hydraulic plant required in using the high head or fall.

The San Joaquin Electric Company's plant is pointed out as being a model of a modern transmission plant. This is largely due to the peculiarly favourable location.

The Canal.

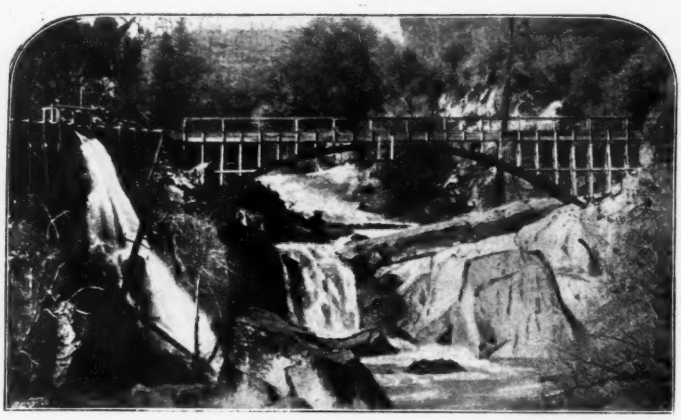
Nature appears to have foreseen the necessities which have led to the development of water-powers and their utilisation by the means of electricity, and the hand of man could not have executed a more favourable plan than that upon which the water power of the San Joaquin Electric Company has been developed. High in the Sierras, and well within the winter snow line, the North Fork of the San Joaquin River makes its precipitous descent to the valleys below. Until well in the summer each valley adds its quota of water to the stream, but only the waters from the larger canyons have perennial flow. Of these, the North Fork and the south branch of the North Fork of the San Joaquin River were selected as head waters. No dam or structure of any sort, other than simple fluming marks the diversion points, the flumes being simply extended into the banks at the side of the streams, or well bolted to bed rock, continuing thence to their confluence. The canal thus formed is about seven miles in length, of which 4,000 feet is of wood flume, and the remainder is ditching. Waste gates have been placed in the canal at every 4,000 feet, and the canal has a capacity of 70 cubic feet of water per second.

A small portion of the flume has been built on solid rock, orming the bed of the river. The severe freshets that occur during the winter months necessitate the utmost rigidity in securing the flume to the rock. This was done by anchor bolts, consisting of heavy iron, split at the end from 4 to 5 inches, and into which steel wedges were started. The bolts, with the wedges started, were then driven into holes that had been drilled into the solid granite, and the spreading thus caused by the wedge rendered the withdrawing of the bolt practically impossible, but greater security was given by filling the holes with melted lead. So firm has this construction proven, that the storms and freshets of the past winter have not affected the flume in any way. The ditch is built throughout in a reddish loam, which settles and packs, so that no seepage occurs.

A novel design for a bridge to carry the flume across the gorge of the North Fork is the wood arch structure shown in the fig., which consists of 1 inch × 14 inches × 12-feet boards spiked together, building up to the bow, the boards being dipped in hot asphaltum before being put on. The boards are put on so that the joints are broken with each layer, and built to a thickness of 16 inches. The bows are built in place on a batter of 1 in 6, being the same batter used in the trestles of the flumes which are built upon the bows. The bows are tied together with iron rods, and guyed to rocks on each side with one-half inch steel cables. All the flumes are calked with oakum, and all the inner surface and the joints were coated with hot asphaltum when put up. The flumes are set on a grade of 3 feet in 1,000, and the canal on a grade of 1 foot in 1,000, except a portion of the canal where the grade was flattened to $\frac{7}{10}$ths of a foot in 1,000, where it was necessary to avoid heavy cutting.

The flumes and the canal are built in a very substantial manner, and hence have given very little trouble by reason of breakage. Waste gates are provided at every 4,000 feet along the canal, and sand traps are placed at such places as needed to keep the canal clear of running sand.

With these appliances there is very little difficulty of handling the water; in fact there have been no interruptions whatever caused by troubles at the diversion works.



Wooden Arch Flume Structure Across the North Fork.

The Reservoir.

An interesting feature in the development of the water-power consists in the peculiar topographical formation of the ridge upon which the reservoir has been located. This ridge extends out as a spur from the backbone of the main North Fork Ridge, and is bounded on one side by the North Fork of the San Joaquin, and on the other by Fish Creek. It is around this main ridge that the canal is carried, and Reservoir Mountain, as the spur is aptly termed, consists practically of a table land with three sides very precipitous. The area of the reservoir is about 8 acres, and it was formed by throwing up an earth embankment to a height of 8 or 10 feet for a distance of about 500 feet. Its storage capacity is sufficient to operate the transmission plant to full capacity for between 5 and 6 days.

Water may be supplied to the pipe line either from the reservoir or direct from the canal, an additional 800 feet of which has been constructed to subserve this purpose. The head of the pipe line, together with bifurcating gates, pressure box, and air inlet stand pipe, is shown in another fig.

Pipe Line.

The pipe line consists of practically three sections, according to the variety of pipe used. The first 1,820 feet is of riveted pipe, 24 inches in diameter, the first 980 feet of which is of 12-lb. steel, and the remainder is of $\frac{1}{4}$-inch steel. Then follows the second section, consisting of 400 feet of converse lock-joint, lap-welded pipe, 20 inches in

diameter, and having lead joints. The last section, which is also 1,800 feet in length, and has a diameter of 20 inches, consists of lap-welded pipe, with flange joints bolted and made tight with rubber gaskets. The entire length of the pipe line to the receiver is, therefore, 4,020 feet. The first section was built by the Risdon Iron and Locomotive Works of San Francisco, and pipe for the remaining sections was furnished by the Dunham, Carrigan & Hayden Company of the same place, and was made by the National Tube Works, of McKeesport, Pa.

As stated, water may be conveyed to the pipe line either from the reservoir or the canal direct, and to prevent litter from being carried down the line, the openings of the pipe lines have been provided with bell mouths, each 6 feet in diameter across the mouth, containing 1,800 ½-inch holes. From the Y a 12-inch stand pipe, below the valve gates, extends to a height above the level of the reservoir. The bifurcating gates, as well as all other gates and relief valves, were made by the Risdon Iron and Locomotive Works Company.

Much difficulty was experienced from unappreciated causes in the erection of the pipe line, and being about 4,000 feet in length and running over different geological formations, various expedients had to be resorted to to secure stability. At some portions the pipe line has been buried to a depth of from 5 to 8 feet in the soil. Elsewhere it is supported on saddles, but the general construction consists of bolting the pipe firmly to the massive granite bed-rock. Stay rods, or holding-back bolts, are not used, but instead the pipe is held down in the manner above described for holding down the flume. With the pipe line, however, the split bolts are sulphured into the granite to a depth of from 5 to 7 feet, and to the bolts are screwed semi-circular, flat iron bands, 2½ inches × ⅝ths inch in size, placed on top of the pipe.

The pipe line was built from the ends towards the centre, and as the time for closing the gap approached, a new obstacle appeared. Early in the morning, before sunrise, the gap between the pipe ends, and which is best termed "the cold gap," was 7 feet 8 inches. In the afternoon, and about sunset, this gap would close to exactly 7 feet, giving "the hot gap" due to the expansion of the pipe by the heat of the sun.

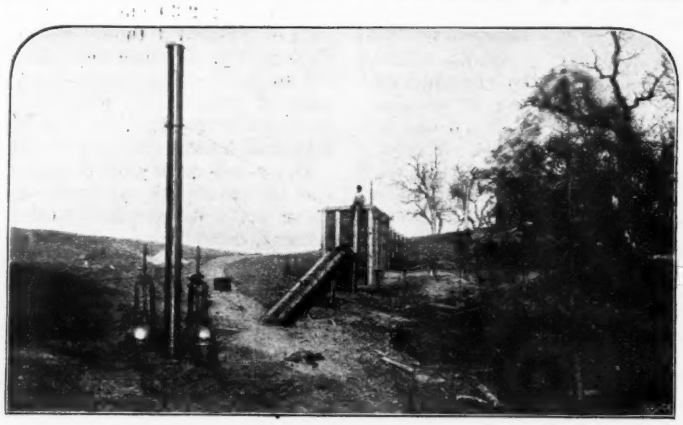
Section 1, consisting of 24-inch riveted pipe, was built first, the construction being begun at the lower terminus and laid from the bottom upward, the pipe being held in place by heavy timbers, known by boiler makers as "dead men." The lap-welded, or 20-inch pipe, was laid from the receiver upwards, leaving a gap between the reducer piece or taper joint on the riveted pipe and the last bell on the converse lock-joint pipe. The closing of the gap was thus resolved into the problem of finding the minimum temperature of the pipe, then closing the opening and filling the pipe with water before sunrise. All tools and materials were got ready, and at 2.30 a.m. the gap measurement was taken, a piece of lap-welded tubing was cut to fit and then driven in place tightly. A loose bell was used and the rib chipped out, so that it slipped freely over the edge of the pipe at the point of splicing, and when the connecting piece was in place and slipped over, the joint was filled with lead on both sides and calked, thus completing the pipe.

One is not to be disappointed in the natural expectation that the installation and operation of a pipe line of this character would be attended by many peculiarities, if not phenomena, entirely new. Operated as it is, under a head of 1,411 feet, and having imposed upon it the trying conditions incident to the control of hydrostatic pressure of 609 lbs. per square inch, the requirement that electric generators shall be operated at a practically uniform speed, necessitates the exercise of the greatest ingenuity in the design of water-wheel governors, and the San Joaquin pipe line, being strictly the pioneer in that direction, has had imposed upon it both the use and abuse that would naturally fall upon the first undertaking of the kind. It is with a view that the difficulties experienced may be obviated in future installations of this character, that considerable space is given to them.

Flume Construction at Point of Diversion, Showing Simplicity and Safety of Head Works.

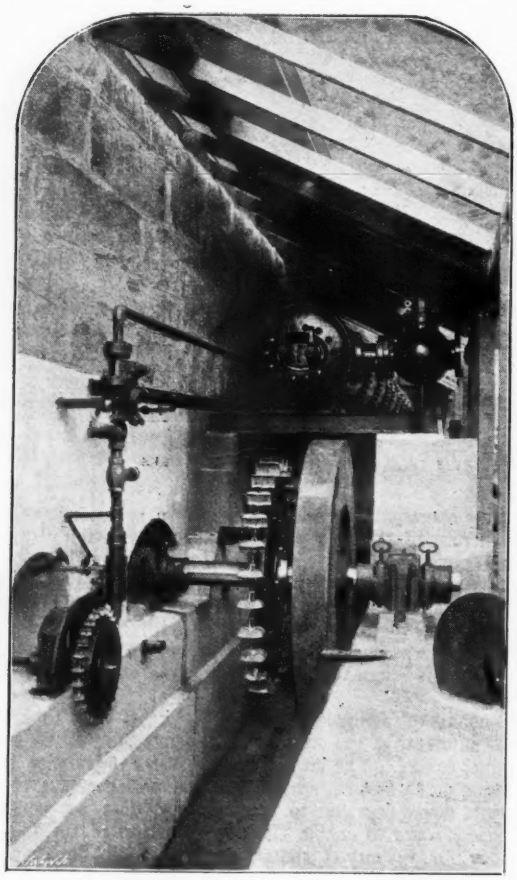
Students of acoustics may care to know that to bellow into the mouth of the empty pipe line invariably causes seven distinct echoes. The normal flow of water in the pipe is at the rate of 1½ feet per second, and the present plant in the station, when operated to full capacity, does not consume sufficient water to enable the determination of the friction head. The velocity of the water from the 1½-inch nozzles used is something over 9,200 feet per minute, and nothing is more impressive of the terrific energy of water at this head than a recital of some of the difficulties that have been encountered in controlling it. The general features of construction that have become well established by the erection of many plants operating under heads of from 500 to 600 feet or less were first carried out in this installation; but subse-

quent experiences compelled their abandonment, and the design of special features to satisfy the conditions found to exist. In the wheel pit for instance, and in the tail race, all masonry construction is of the most solid character. The wheel pit was carefully closed over by heavy planking, and upon turning on the water it refused to go out the tail race and along the bottom of the ditch; but instead rolled up the sides of the pit, or followed up the water-wheels to the plant covering, and along the under side of the planks it rushed madly out, almost horizontally, for a distance of 60 feet, where it struck a great granite boulder, and was lost in spray.



Head of Pipe Line, Showing Bifurcating Gates, Pressure Box and Air Inlet Stand Pipe.

The jets strike the wheels at an angle of 45° from the horizontal, and the nozzles being deflecting, the impact water strikes the bottom of the wheel pit with terrific fury. After two days operation the water had cut under the concrete and into the seams of the bed-rock, coming out in the power house and outside of it. To obviate this a 14-inch steel pipe, 4 feet in length, and having a heavy steel plate across the lower end, was let into the bottom of the wheel pit in line with the jet, the idea being that the pipe would fill with water and form a water cushion to take up the blow. Instead of doing this, however, it merely reversed the direction of the stream, and the waste water landed on top of the power house, not taking the usual course. Then some one recommended that the wheel pit be dammed up so as to carry 2 or 3 feet of water, which would tend to prevent the emptying of the cushion pipe, with the only difference from the preceding experiment being that in addition to the waste water the water impounded in the wheel pit was also landed on the station roof and thereabout. Nevertheless, the "water cushion" pipe was allowed to remain, but it was filled level full with concrete, and the bottom was completely floored over with 3-inch planking, which was sheathed for 3 feet about the nozzle with $\frac{3}{8}$ths inch steel plates. At that time the water was slightly muddy, and considerable granite sand had been washed into the tail race, and as a result in less than three days, a $\frac{1}{4}$-inch jet which had been left in had worn its way through the steel plate and the 3-inch planking, and was at work upon the demolition of its old old enemy—concrete and masonry. The heroic method of feeding a fresh chilled cast-iron plate, $3\frac{1}{2}$ inches in thickness, to it as often as necessary, has now been resorted to as the best solution of the problem, and has proved very satisfactory.



60-inch Pelton Water Wheel and 6,000 lbs. Flywheel and Frame Shaft, Showing Method of Setting on Concrete Wall.

The weight of the water contained in the pipe is approximately 317 tons. The end thrust thrown upon the receiver is about 93 tons, to withstand which four $2\frac{1}{2}$-inch stay bolts solidly bolted to the receiver have been embedded in bevelled abutments. The receiver itself is 57 feet in length, with a diameter of 30 inches, and is constructed of $\frac{3}{4}$-inch flange steel, with a tensile strength of 60,000 lbs. and an elastic limit of 30,000. External and internal butt straps are placed thereon in 5-foot courses. It is riveted throughout with 1 inch rivets, and the stay bolts for withstanding the end thrusts are welded to $\frac{3}{4}$-inch boiler plates, 10 inches in width, that are in turn riveted to the shell of the receiver. All mountings, including the nozzle saddles, are of cast steel. Before leaving the Risdon Iron and Locomotive Works, where it was built, the receiver was tested to 800 lbs. hydraulic pressure, which was considered noteworthy; but since its installation it has been subjected to a far greater strain without injury, the pressure being over 1,200 lbs. It did not take long after water had been run into the pipe to demonstrate that while water at a head of from 5 to 6 hundred feet may be considered a liquid, yet at a head of 1,400 feet it becomes a solid with the strength of the hardest steel. The gates and relief valves ordinarily used were placed upon the equipment. The relief valves in particular had, up to that time, been considered perfection, and the balanced internal pressures were so thoroughly worked out as led to the belief that they would operate satisfactorily under any pressure, but the vital point of the friction which ensues from the contact of metal with metal when under high pressure was under estimated, and as a consequence the relief valves are practically inoperative. It is the belief of the engineer in charge, that at high pressures water must be relieved by something cumulative. The use of compressed air is impracticable, because of the fact that the air will be forced into the water and the practice finally adopted for protecting the equipment from water hammer, consists in the adoption of gates for controlling the rate of opening and closing, rather than in the use of relief valves.

The experience with this pipe line has, as stated, made it plain that when water is under high pressure in a large column, it becomes the equivalent of a solid bar of equal weight, standing on end, and it is from handling this column of water, 4,000 feet in length, weighing 317 tons, and exerting a pressure of 609 lbs., that the conclusion is reached that this column of water must be handled in exactly a similar

manner as would be devised for handling a solid column of like dimensions, namely, time must be an element in stopping and starting the column in order to overcome the "water shock," or combined force of the momentum force of the water itself, and the expansion and construction of the containing vessel. With this idea of "time," as a simple thought, the volume should be set in motion and brought to rest by a device that would be the equivalent of withdrawing an inclined plane, the taper of which is represented in the time required in getting the column in motion, or in other words, to handle water successfully under extremely high heads, there is only one true and safe way, and that is by means of screw gates, as by this means the column of water can only be started or stopped very slowly. If this method is employed water shock, and relief valves for taking care of the same, will be an unnecessary problem.

Under the head of relief valves for very high pressures, the conclusion reached is that any method whereby water is discharged is more liable to cause constant increase of water shock than otherwise, as it has a tendency to increase the velocity of the water column, which in itself is the primary cause of water shock, and hence the conclusion is that devices for handling high heads should be so arranged as to make water shock absolutely impossible, however careless operatives may be.

Auxiliary Pipe Line.

One of the difficulties encountered in using an extremely high head, is the exceedingly small orifices required for a small quantity of power on small wheels for driving exciters separately. To overcome this difficulty a separate pipe line was put in for this purpose, taking the water from the main pipe line into a pressure tank, and using it from the tank through a 4-inch pipe under 200 lbs. pressure, for driving the exciter wheels. The water is taken from the main pipe through a short length of 1½-inch pipe, controlled by a valve gate, and is discharged into a "boat" to break its force, and is screened before using, and the pressure box is provided with blow-off and overflow pipes, so it is automatic in its operation. A separate pressure gauge in the power house shows the pressure.

The receiver is mounted alongside the power house, and directly beneath it are the Pelton water-wheels, constituting the power plant. Independent single jet Pelton wheels are furnished for each generator and exciter. In the main wheels the Pelton wheels have an outside diameter of 57 inches, and each wheel carries 27 buckets bolted to its periphery. The speed is 600 revolutions per minute. On the same shaft with the main wheel is seen the 6,000-lb. fly-wheel, 60 inches in diameter, with which each wheel is provided. On the periphery of the fly-wheel is shrunk a heavy cast-steel hand 2 inches thick, to prevent its disruption at high speed from centrifugal force. As the water-wheel and generator outfit is direct connected, and as the armature weighs about 7,000 lbs., the total mass available for fly-wheel effects aggregates 12,000 lbs. The diverting nozzle mode of regulation is used.

(To be concluded.)

THE TEMPERATURE OF FLUE GASES.

[COMMUNICATED.]

Referring to some recent remarks in the Electrical Review in criticism of some flue gas final temperatures, and to Mr. J. F. Snell's objections and corrections, it may not be out of place that the probabilities should be looked into by means of known figures. In order not to introduce unnecessary complication, it may safely be assumed that the fuel shall be pure carbon. The perfect combustion of pure carbon requires a proportion of oxygen = 2·667. Reducing to air this means that 1 lb. of carbon requires a minimum of 11·32 lbs. of air, and produces a total of 12·32 lb. of gases. The specific heat of these gases may fairly be taken at 0·236 for all ratios of air, so close are the specific heats at constant pressure of all the products of a furnace. The total heat of combustion of 1 lb. of carbon perfectly consumed is 14,100 B.T.U. This amount of heat is divided amongst the 12·32 lbs. of total gases, and if we divide 14,100 by this weight we get the figure 1,144. Dividing this again by the specific heat ratio 0·236, we get 4,840 as the temperature of perfect combustion. This is on the assumption that the specific heat does not vary with temperature, and this may safely be assumed for the present purpose, because though it probably does vary with temperature, we have to deal actually with much lower temperatures than 4,840°, and any temperature locked up at the higher ranges will come out again at the lower ranges.

In actual practice the amount of air used in a furnace per lb. of carbon will vary up to double the theoretical amount. Let it be assumed that each lb. of carbon uses 20 lbs. of air and gives 21 lbs. of gases. The temperature of combustion will be proportionately reduced, and instead of 4,840° the temperature will be $4{,}840 \times \frac{1{,}232}{2{,}100}$ or say 2,840° Fahrenheit, which would be the excess above atmospheric temperature. In Mr. Snell's paper as corrected by himself he claims a flue temperature of 350°, or say 300° above the atmosphere. If this temperature of 300°+50° was got from a furnace gas coming from a furnace at 2,840° + 50°, as would be the case if 20 lbs. of air were used per lb. of fuel, it is obvious that the efficiency of that boiler must be $\frac{2{,}840 - 300}{2{,}840}$ or 89·4 per cent.

There are two ways out of this dilemma, for a dilemma it surely must be, for no one who knows anything of boilers will pretend that any boiler has an efficiency of nearly 90 per cent. One way out is to grant a larger weight of air per lb. of fuel than 20 lbs. The other way is to suppose that the same result is obtained by large leakage of air through bad brickwork. In no other way can a low final temperature be explained. Low temperatures at the chimney end of water-tube and other boilers have so frequently been put forward, and in all good faith, that it is high time that the simple facts of temperature were pointed out, and the very simple method of calculation of these temperatures plainly stated. If a boiler has a 90 per cent. efficiency it is capable of evaporating 13½ lbs. of water from and at 212°. We have no doubt that there may be boilers so badly set that the gases are cooled down by air leakage to abnormally low temperatures, but a reference to Mr. Snell's paper to which the Electrical Review directed its criticism will bring to view a table of results of various boilers. Five of these are given an exit flue temperature and this varies from 285° to 519°. The average of the five is 433°. In the case of the one so low as 285° the evaporation from and at 212° is only 11·9 lbs. for that perfect fuel Nixon's navigation, rated within about two-thirds of one per cent. of pure carbon or simply at 14,400 units. The steam pressure in this case is given at 173½ pounds. The pressure corresponding with this is 375°, so that in this case the furnace gases are cooled no less than 90° below the temperature of the boiler which cools them. The steam pressure, the gas temperature, and the evaporative efficiency are hopelessly at variance. Probably the error has been chiefly in the means of taking the gas temperature, but enough will have been advanced to show the fallacy of so many of the figures put forward to support boiler tests.

In the same table a Lancashire boiler with about 960 feet of additional heat absorbing surface in a tubular economiser rejects its gases at 473°, which is about fitting, and yet it is allowed 12·46 lbs. evaporative efficiency from and at 212°. The boiler in this case is at 120 lbs. pressure and the economiser being cool would certainly reduce the gases below 473° in many cases.

Every boiler in the table might be carefully examined in regard to its main figures, and serious discrepancies would be found, showing how little is known as to actual facts of combustion or furnace leakage.

Without impugning the good faith of any testing engineer, there can be no harm in calling for a careful scrutiny of figures obtained in boiler testing.

American Brush Plant.—Brush machinery and plant has been on the American market for over 20 years, and is to-day popular and in demand there. A contemporary says that the recent development of C. F. Brush dynamos with capacities of from 55 to 300—2,000 C.P. lamps has caused many lighting companies to change from small units to the larger dynamos with most satisfactory results.

CORRESPONDENCE.

Colonial Electric Lighting.

As a subscriber to your journal for this past five years I have frequently seen articles in your columns on the above subject, and believing that a few notes will be of interest I herewith append the following.

I have recently investigated the affairs of the lighting companies in Melbourne, and as there is at the present time an attempt by Mr. R. A. Dawbarn on behalf of the "Brush Company" to amalgamate two of the companies and in view of the opposition of the City Council and municipalities within the suburban area, a brief review of the situation may be of interest.

Upon reviewing the recent Act of Parliament passed by the Legislative Council of Victoria, Feb. 10th, 1896, it is apparent that the Act is framed solely in the interests of municipal lighting, and although the vested interests of the private companies have been considered "to a certain extent," the following clauses will indicate the narrow limits within which this has been done.

Upon consulting the Act, Clause 6 states that the companies in existence prior to the passing of the Act are entitled to an order for their lines and works in existence prior to July 16th, 1895. This upon perusal seems only just and of some value, but turning to Clause 43, Subsection 3, I there find that such companies are liable to be bought out (by the council or councils within whose districts they are working) within two years from the granting of the order or within six months from the expiration of 12 years or within six months from the expiration of 25 years. These clauses would have a tendency to considerably hamper the progress of any company, more especially as the general feeling is in favour of municipal lighting. Little can be said of the terms of purchase, for I find in Sub-section 4, Section 3, it says the value of such works, &c., shall be deemed to be their fair market value at the time of purchase, due regard being had to the nature and then condition of such works, &c., and also to the suitability of same, but without any addition in respect of compulsory purchase or of goodwill or of any profits which may be or might have been made from the undertaking.

The question of suitability is a serious one, for I am informed that the companies have all adopted different periodicities, viz., 45, 83, 120, whilst that proposed by the City Corporation is 125. Upon a close inspection of these figures it would appear that the least suitable would be 45. Further, the question of suitability may be important when it is remembered that the two largest stations are about two miles beyond the city boundary.

Returning to Section 7, I find that the companies are allowed to supplement the order to which they are entitled by a second order. This, however, they have still to do, and owing to the adverse attitude the councils have already taken up, it is extremely doubtful whether this will be obtained. However, should the extended order be obtained it would come under the purchasing clauses and expire with the first.

Upon referring to the model order I find a clause which has, I believe, been copied from the English order, prohibiting the buying, selling, or amalgamation of electric companies. The reason of this I fail to see; but it may prove a serious obstacle if my information "*re* amalgamation" is correct. True, the decision of this matter rests with the Minister; but I question whether he has the power.

Upon a close inspection of the regulations, it is also evident that much work and money will necessarily be expended on the mains and apparatus to bring them to the standard required under the Act, and if the tenancy is for two years, "*Cui Bono*." It would therefore appear that any scheme "placed before would-be investors" demands a close study of the conditions.

I enclose a copy of the Act and regulations for your perusal; the state of affairs in Melbourne may be summed up by one word—"Chaos."

Fredk. Fullarton.

Cardew Earthing Devices.

We note in your last issue a description of earthing devices made on the principle of the old-fashioned lightning arrester, which claims for its advantages that it does not depend upon any static electricity for its action. We need hardly say that this old-fashioned lightning arrester naturally suggested itself when the necessity for an earthing device was discovered. The tests, however, that were made showed that under varying conditions of atmosphere the lightning arrester was unsuitable for the purpose, hence the adoption of the very ingenious application of the static charge patented by Cardew. Further, it is a retrograde step to make use of a relay and a switch. This is described fully as an alternative method in one of Major Cardew's patents which we purchased, and we are taking advice on the whole subject of this patent.

It was found in practice that nothing was required but two plates and a thin foil lying between them, thus having no pivots to get out of order, no springs to rust through, and no fine wire which may be broken by any jar, and thus permanently earth the secondary. There are thousands of these in use in every part of the world, and it is not too much to say that we have not found one single instance where they have failed to act successfully.

You do not say in your description whether this earthing device has been seen and approved by the Board of Trade for use in connection with any high tension supply system. If so, we shall be glad to know where.

Drake & Gorham.

Alternating Arcs.

In reference to your remarks on Street Lighting in last week's issue, will you allow me to draw the attention of your readers to the fact that one part of Regent Street (Oxford Circus to Portland Place) is lighted by alternating arcs, and the other part by continuous current arcs, so that, when standing at the junction of Regent Street and Oxford Street, an opportunity is afforded of comparing the two systems by a mere turn of the head.

There is no doubt in my mind as to which portion of the street is the better illuminated, but—I am prejudiced.

Bennett Pell.

Electric Pumping—South Staffordshire Mines Drainage.

It is a relief to find from your note on this subject that Mr. Edward Howl has at last come round to the opinion that there is after all some advantage in pumping water by electric power. "*The question of electric pumping is most important*," says Mr. Howl! Indeed! Some of us were trying to impress this upon him years ago, but with apparently little effect. The simple method of preventing three or four million gallons (winter surface water) per day getting below, by means of centrifugal pumps, electrically driven, has been staring the Commissioners in the face for some years; but it isn't until an electrical company comes along and forces their hand, that the fact receives any sort of recognition.

Now that some of the gilt has peeled off, it is to be hoped that the "hydraulic scheme" will receive some further attention. An eminent *consulting* engineer* (principal partner in the most important *manufacturing* hydraulic engineering firm in this country) is called in to advise the Commissioners, and draws up this *hydraulic* scheme. Naturally; what else was to be expected; but Mr. Howl and the Commissioners need not have swallowed it so readily. The question of spending another £100,000 in pumping plant deserves consideration from the electrical point of view, especially when it is over a distributed area, as in this case. The writer is therefore glad to hear that this hydraulic scheme is proving somewhat indigestible, and that some work he assisted a few years ago has not been quite thrown away.

E. Kilburn Scott.

Induction through Sea-Water.

In your issue of the 9th inst., "F. R. G." asks me to answer in your columns a number of questions about my proposal published in your issue of the 2nd inst.

Most of your readers will probably have answered these

* Mr. Henry Davey, 3, Princes Street, Westminster, and Messrs. Hathorne, Davey & Co., Sun Foundry, Leeds.

questions for themselves, but there may be some like "F. R. G.," who cannot do so.

1. Would "F. R. G." be so good as to give a description of the means he would propose for connecting the ship and shore by cable direct?

2. Communication could be made at certain hours of the day, and on special occasions a signal (such as a rocket) could be given.

3. My sketch shows only the means of communicating from the shore to the ship. The reverse operation would require another bell and funnel, also a telephone transmitter and receiver.

The second part of the last question is not devoid of humour.

Archd. H. Finlay.

THE ENGINEERS' STRIKE.

We extract the following from a very excellent article on this vital question in Wednesday's *Standard*:—There is no indication this morning of any peaceful settlement of the engineering dispute, and the whole industry is in a state of insipient paralysis. The manifesto issued by the Amalgamated Society of Engineers endeavours to make it appear that their demand for a shorter day without reduction of pay is perfectly reasonable and practicable, and that the combined movement of the employers in enforcing a lock-out originates solely in a desire to crush the Trade Union. This attempt to place responsibility for the conflict on animosity towards Unionism is by no means likely to deceive the public. It is especially to be observed that a notice, designated an "ultimatum," was served upon Messrs. Humphrey & Tennant, Messrs. Thornycroft, and Messrs. Middleton and Co., stating that unless the eight hours' day was conceded by a certain date, the members of the Trade Unions specified would forthwith cease work. It was in consequence of this action that the engineering employers throughout a great part of the kingdom joined up their forces. The action of the masters was defensive, while that of the men was undeniably aggressive. If combination on the side of the men was justifiable, it was equally fair in the case of the employers. The federated masters declared that, if there was to be a strike in London, they would meet it with a lock-out. The strike has taken place, and the lock-out, therefore, has commenced. The latter was designed to proceed by instalments, a portion of the men being discharged each week, but the Amalgamated Engineers have accelerated events by ordering all their members to cease work wherever the lock-out has begun. With facts like these presenting themselves, it is evident that the outbreak of this industrial war has been caused by the Amalgamated Society and the Unions associated with it.

The danger now threatening the engineering and shipbuilding industry of the kingdom is lamentable, not merely on account of the immediate mischief, but also in view of the consequences likely to accrue further on. Trade arrested in this country will inevitably tend to find its home elsewhere. The world will not stand still while Trade Unions quarrel with their bread and butter. Ships will be built and engines will be constructed somewhere—if not here, somewhere else. But whether the strike will either be so long or so severe as we might readily imagine, is open to some doubt. One thing the men may rest assured of, that their conduct in forcing on this strife does not meet with public approval. The manifesto of the Amalgamated Engineers pleads for the elevation of the working man, and to this everybody will assent. But how is the plea supported? The workman, we are told, is to be given more leisure, so that he may have more home life, and cultivate aspirations worthy of his manhood. There is, however, a very prevalent idea that the demand for a shorter day is really a cover for higher wages. Where is the guarantee that the eight hours' rule will be observed by the workmen even when the employer is willing to grant it? Those who best understand the situation and the tactics of the Trade Unions have a strong suspicion that the eight hours' movement is only the wages question in another form. The employer is to give the pay of nine hours for the labour of eight. When the work goes on for a ninth hour that hour will be overtime, paid for at an extra rate. To tell an employer that the work done in eight hours will be equivalent to what was formerly done in nine is to signify that his workpeople have hitherto "skulked." But a machine cannot skulk, and machinery is in such connection with labour in the present day that it is less practicable than formerly for a man to trifle with his task. But while wages must form the main consideration with the workman, to the employer the question is one of profits. On this point he is better informed than the workman. The parties to the manifesto of yesterday say, "We do not intend to be coerced by a federation of employers." In like manner, employers do not intend to be coerced by a trade union. If the latter steps in to manage the business, it must be content to share the losses. Of this, however, we hear nothing, and the argument is addressed to the British public that if this country is to hold its own in the markets of the world, nothing will answer the purpose so well as high wages and short hours. The proposition is one that requires more evidence than has yet been supplied.

LEGAL.

The Metropolitan Electric Supply Company, Limited, *v.* Samuel Wheeler (The Official Receiver and Liquidator of the House and Investment Trust, Limited.)

In the House of Lords on July 9th before the Lord Chancellor and Lords Herschell, Watson, Shand and Davey, an appeal from a judgment of the Court of Appeal reversing a decision of Mr. Justice Romer was heard. It appeared that the House and Land Investment Trust are the lessees of Whitehall Court, on the Thames Embankment, and in 1888 they entered into an agreement with the appellants to construct a chamber on land belonging to them under Whitehall Avenue for machinery and engines to manufacture electricity, and on the completion of the work they agreed to grant to the appellants a lease of the premises for 90½ years from October 10th, 1887, at a rent of 10 per cent. upon the outlay and £10 a year in addition, the appellants on their part undertaking to supply the establishment with the electric light. The question raised was how the price to be paid for electricity was to be ascertained. Mr. Justice Romer decided that "lump sum" contracts, *i.e.*, contracts to supply electricity at a lump sum per annum to customers, ought not to be brought into account for the purpose of ascertaining the amount payable by the respondent. The Court of Appeal, however, consisting of Lords Justices Lindley, Lopes, and Kay, reversed that decision, and held that such contracts ought to be brought into account; hence the present appeal.

At the conclusion of the arguments,

Their Lordships reversed the decision of the Court of Appeal, and restored the judgment of Mr. Justice Romer.

The appeal was accordingly allowed with costs.

Cackett *v.* Dickinson.

Before Mr. Justice Grantham at the Northumberland Summer Assizes last week this case was heard. Mr. Cackett, an architect of Newcastle, sued Mr. Dickinson, also of Newcastle, on account of the alleged nuisance caused to him by the working of a dynamo used by the defendant to supply electric light to his house. From the statement of Mr. Meynell, who appeared for the plaintiff, it appeared that the two parties lived in Brighton Grove, Newcastle. Mr. Dickinson is the owner and occupier of 127, Brighton Grove, and Mr. Cackett himself lived at No. 129. It appeared that Mr. Dickinson had laid down a dynamo in the back yard, to supply electric light to his house, and it was alleged that there was a disagreeable vibration from it, and that owing to this, the gas jets jumped considerably, and it was altogether a considerable source of annoyance.

Before proceeding to take evidence his Lordship suggested that the jury should visit the house and see the engine working and the effects caused by it.

Mr. Strachan, who with Mr. Scott Fox defended, agreed to this course, and the case was adjourned.

Torkington *v.* Hughes.

In the Westminster County Court on Wednesday, Colonel Torkington, late of the Army, sued Messrs. Hughes & Co., patent agents, of Chancery Lane, for the return of such a portion of the sum of 12 guineas that was not spent by them in connection with obtaining provisional protection for a novel electric lantern for cycles.

Plaintiff's case was that on October 15th last he was proceeding up Chancery Lane with the intention of going to the Patent Office to patent an idea for a cycle lantern. The lantern was to be connected with a dynamo which was connected with the cycle wheels, the cyclist creating his own light as he went along. Plaintiff walked into the Government Patent Office, as he thought, and disclosed his invention. He found it was Messrs. Hughes' office, and ultimately agreed to deposit 12 guineas to let defendants see the thing through as far as obtaining provisional patent protection. Nothing further than provisional protection was to be obtained unless he gave his consent. He gave no consent to the matter going further, and contended all defendants' need have spent was £4 8s. He claimed the balance.

For the defence it was contended all but £3 had been properly spent in obeying plantiff's orders.

His Honour Judge Lumley Smith, Q.C., examined the documents in the case, and said he should give defendants 6 guineas for their labour and £1 for the stamp, and that would be judgment for the plaintiff for £5 6s. without costs.

Blackburn *v.* Harrison & Son.

At the Hanley County Court on the 14th inst., before his Honour Judge Jordan, Mr. Joseph Blackburn, electrical engineer, of Nottingham and Hanley, sued to recover £12 from Messrs. Harrison & Son, colour manufacturers, of Hanley, for repairing a second-hand dynamo. Mr. Blackburn paid £30 to Messrs. J. H. Holmes & Co. for the dynamo and indeed bought it as Messrs. Harrisons' agent, and charged them 12½ per cent. commission. The dynamo was fixed by the defendants' men in a solid bed in January, 1893, and for 18 months worked well. Then it was, to suit the convenience of the defendants, removed, and put in a new bed in another house, again by Messrs. Harrisons' men, who did not know a great deal about the work. It did not work satisfactorily, and in July, 1895, and in April, 1896, the dynamo was mended by the plaintiff, who now charged for the repairs executed.

There was a counter-claim for £20, on the ground that the machine was not fitted for the purpose for which it was ordered.

A verdict was given for the plaintiff on the claim and counter-claim.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending July 13th, 1896.	£	s.	Week Ending July 13th, 1897.	£	s.
Adelaide	25	0	Albany	43	0
Alexandria	22	0	Alexandria. Telep mat.	103	0
Amsterdam	150	0	Amsterdam	50	0
Baltimore	18	0	Antofagasta. Teleg. mat.	53	0
Bilbao	56	0	Bombay	45	0
Boulogne	18	0	Boulogne	118	0
Buenos Ayres	830	0	Buenos Ayres	380	0
Cadiz. Submarine cable	7,300	0	" Teleg. mat.	132	0
Callao. Teleg. mat. ...	22	0	Calcutta	297	0
Calcutta	13	0	Cape Town. Elec. mining machinery	245	0
" Teleg. wire ...	69	0	Cape Town. Teleg. mat.	2,521	0
Cape Town	420	0	Copenhagen	120	0
Colombo	200	0	Durban	217	0
Durban	48	0	Fremantle	90	0
East London	367	0	Gothenburg	30	0
Gijon	8	0	Hamburg	53	0
Hong Kong.	86	0	Hong Kong	32	0
Melbourne	360	0	Liban	350	0
" Teleg. mat.	242	0	Melbourne. Teleg. mat.	148	0
Novorosisk	1,200	0	Newcastle. Electric machinery	2,078	0
Odessa	200	0	Odessa. Teleg. mat. ...	77	0
Port Elizabeth	147	0	Ostend	25	0
" Teleg. mat.	775	0	Port Elizabeth	398	0
Rangoon	84	0	Port Said. Teleg. wire	994	0
St. Petersburg	40	0	Rosario. Teleg. mat. ...	395	0
Santos	77	0	Rotterdam. Teleg. wire	63	0
Singapore. Teleg. mat.	2,610	0	St. Petersburg	122	0
Stockholm. Teleg. mat.	655	0	" Teleg. wire	888	0
Suez	10	0	Santos	77	0
Sydney	343	0	Shanghai. Teleg. wire	872	0
Vera Cruz	110	0	" Teleg. cable	9,973	0
Wellington	489	0	Stockholm	400	0
			" Teleg. mat. ...	944	0
			Sydney	307	0
			Vera Cruz	24	0
			Vigo. Teleg. mat. ...	50	0
			Yokohama	450	0
Total	£16,994	0	Total	£23,164	0

Foreign Goods Transhipped.

	£	s.		£	s.
Trinidad. Teleg. mat. ...	95	0	Wellington. Teleg. wire	15	0

Arc Lamp Catalogue.—We have received the arc lamp catalogue of Mr. L. Bardon, of Clichy, Paris, with full particulars of his various types of lamps for continuous and alternating currents. Judging from the description and drawings of the lamps, the claim of the manufacturer that they are simple in construction, and not liable to get out of order, seems fully substantiated. An installation of over 500 lamps in the Grands Magasins des Louvre has required no repair during a period of five years. The list includes a table of curves, general price list of accessories, and a list of municipalities and public companies where the lamp is in use. One of our representatives, who saw the lamp in Paris, assures us that it is well made and reliable.

Catalogues.—An illustrated price list of electrical accessories has been issued by Mr. Samuel Harrison, of Pemberton, Wigan. All kinds of small accessorial apparatus for electric bells, batteries, telephones, electro-medical apparatus, model dynamos, &c., as manufactured by the firm, are described by means of letterpress and woodcuts in about 44 pages. This catalogue should be serviceable to the trade, to whom we recommend it.

The Clayton Foundry Company, Limited, of Clayton, Manchester, have published a catalogue illustrating and particularising, and also giving prices of Clayton type of multipolar dynamos, electric motors, the Manchester overtype and enclosed Clayton type of dynamos and motors, worm geared motors, motor switches, switchboards, &c. The details regarding the various machines are arranged in table form for easy reference, and the general get-up of the list is good. We have recently referred to several motor contracts secured by the Clayton Company.

A new plant catalogue (Section VII.) has been issued by the Edison and Swan United Electric Light Company. The get-up and general arrangement of the list are very neat. The blocks are good. Ediswan dynamos of the 1897, and various other types, including the "B" Fawcus-Cowan dynamo, Ediswan alternators, "Enclosed" and "Diamond" motors, Ediswan resistances, combined "Diamond" motor and pump, transformers, and Ediswan boosters, are among the apparatus illustrated. A report covering four pages, by Dr. J. A. Fleming, on a 3,000-watt transformer made by this company is given. His experiments enable him to report very favourably about the machine in regard to iron loss, secondary voltage drop, magnetic leakage, construction and design.

Dissolution of Partnership.—Messrs. L. J. Lawrence and W. H. Butcher, hitherto carrying on business as electrical engineers at 5A, Stafford Street, Bond Street, London, under the style of Lawrence & Butcher, have dissolved partnership as from June 3rd, 1897.

Electric Haulage on Canals.—A proposal is under consideration to substitute electric for horse haulage on the canal between St. Omer and Dunkirk, France.

Electric Fittings.—An art metal fittings catalogue has been issued by the Waltham Engineering Company, containing various French designs for candle, gas, and electric light fittings, electroliers, brackets, candle fittings, pendants, table standards, and fancy switch fittings. Many of the designs are good specimens of artistic work. Prices and general particulars are given in addition to the illustrations.

For Sale.—We understand that various electrical plant and apparatus, including a quantity of accessories, is to be sold by private treaty during the next few days. The goods may be viewed at the premises of the Cycle Components Tube Company, Bournbrook, Birmingham.

Fowler-Waring Cables Company, Limited.—This company ask us to state that they are now manufacturers of fibrous cables, paper cables lead-covered, dynamo wires, small steel cables, and vulcanised India-rubber wires and cables. Mr. Mervyn J. P. O'Gorman is manager, and Mr. J. A. Blackwood is secretary.

Hansen Arc Lamps.—We have received from Messrs. Gülich & McIntyre, of 11 and 12, Great Tower Street, E.C., the agents for the Hansen small power arc lamps, a list regarding same. The lamp, which takes from 1½ amperes upwards, is claimed to give a steady, silent light, with a stationary arc. It is a continuous current shunt lamp for series or parallel burning. In the Hansen lamps, with small globes, it is stated that the carbons can be replaced at any time without trouble, and it is claimed for the small globes that a much better diffusion of light is obtained than by using those of larger size, and at the same time the accumulation of dust and ashes is more easily preventible.

Liquidation Notices.—Creditors of the Apostoloff Automatic Telephone Parent Syndicate, Limited, are required to send particulars of their debts or claims and the usual information to the liquidator, Mr. J. W. Cohen, of 13 and 14, Abchurch Lane, E.C., on or before August 14th.

Creditors of the Lamina Accumulator (Elieson's British Patents) Syndicate, Limited, are requested to send particulars of their debts or claims to the liquidator, Mr. T. F. Smith, 28, Basinghall Street, E.C., on or before August 10th, 1897. The shareholders resolved upon voluntary liquidation on June 28th, at a meeting held at the offices, Broad Street Avenue, E.C., and appointed Mr. Smith liquidator. The reason for the liquidation is that the Syndicate cannot on account of its liabilities continue business.

The shareholders of the Crompton Electric Supply Company of Australia resolved at meetings held at Mansion House Buildings, E.C., on June 16th and July 1st, 1897, to wind up the company voluntarily, Mr. F. R. Reeves being appointed liquidator.

New Business.—Mr. Joseph Bastick (late of Wilson and Bastick, of Manchester), has commenced business as an electrical, mechanical, and ventilating engineer at Carrol Grove, Levenshulme, Manchester. Mr. Bastick has, we understand, had a varied experience in electrical and general engineering work for the past 20 odd years.

Outings.—The St. Pancras Vestry electric lighting staff went for their third annual to Margate, last Saturday. Dinner was served at the Bull's Head Hotel, Margate, Mr. Sydney W. Baynes being in the chair, and Mr. J. T. Baron in the vice-chair. Various toasts were interspersed by songs, recitations, &c.

On Saturday last, the Eastbourne Electric Light Company's employés drove to Battle for their annual outing. Dinner was served at the George Hotel.

On Saturday last (July 10th) the recently-formed company, Henry F. Joel & Co. and Thos. Potter & Sons United, Limited, held their annual holiday at the Crown Hotel, Broxbourne, the employés present numbering about 60. The comprehensive programme included cricketing, racing, archery, fishing, rowing, swimming, driving and singing, a number of prizes being awarded to those who distinguished themselves in the different contests by being either best or worst. Though a long and busy one, a pleasant day was spent, the weather and the facilities for amusement in various ways being everything that could be desired for such a function.

The annual gathering of foremen of Messrs. W. B. Haigh & Co., Limited, of Globe Works, Oldham, took place on Monday last (mechanics yearly day). Arriving at Urmston, bowls were played, and after the usual photograph had been secured, an adjournment was made to the dining room of the Lord Nelson Hotel, and the party sat down to an excellent meal. After the inevitable toasts, bowls were resumed until dusk.

Siemens & Halske.—As recently announced in these columns, the above firm, of Berlin, has been formed into a limited liability company, and will trade under the name of "Siemens and Halske Aktiengesellschaft." The directors are Herren Carl, Arnold and Wilhelm Von Siemens, and Herr Werner Von Siemens.

The Jandus Lamp.—We are informed that the supply and fixing of nearly 300 arc lamps were included in Messrs. Drake and Gorham's contract at the Linotype Company's new premises. Impartial tests were carried out between the "Jandus" and the open-type lamp. The result is that the "Jandus" lamps have been definitely approved, as the quality of the light afforded was preferred. The G.P.O. and other Government departments are now adopting the "Jandus" lamps extensively.

ELECTRIC LIGHTING NOTES.

Aldershot.—Messrs. Crompton have written to the Council stating their intention to apply for a provisional electric lighting order. The Council will discuss the matter.

Bangor.—On the recommendation of the Lighting Committee a sub-committee has been appointed to visit several gas and electric light works, and report upon the information they might thus gain as to the working of gas and electric lighting works.

Bedford.—A correspondent says that almost all the shops in the borough are now illuminated by means of the electric light, and the number of private installations is increasing.

Birmingham.—Carr's Lane Chapel, Birmingham, has lately been re-decorated, and the electric light installed on rather an elaborate scale. The whole of the wiring is done on the double-pole distributing system controlled from a large enamelled slate switchboard fixed in one of the corridors near the organ end of chapel. There are 32 D.P. ways and 29 Chopper switches, also local switches for choir and organ. The chapel is lighted by over 150 lights, four 16-light brass electroliers hanging from panels on the ceiling, also six 3-light and three 4-light electroliers over galleries. The under galleries are lighted with 24 stiff brass pendants. No shades are used on electroliers, but frosted lamps. An interesting feature about the wiring is the doing away with all crosses behind switchboard and bringing in the positive and negative on opposite sides. From the roof the wires are passed down 22 ¾-inch galvanised iron pipes embedded in the walls for over 25 feet. The switchboard is divided into two separate circuits, with separate switch mains and meter. The schools and lecture hall are also to be lighted on a very similar scale. The cost of re-decorating and installing electric light was £2,500. Messrs. Moreton & Wallis did the wiring under Messrs. Lea & Thornebery, consulting engineers. Messrs. F. & C. Osler supplied the fittings.

Blackpool.—We cull the following amusing paragraph from the *Northern Daily Telegraph*, of Blackburn. Perhaps Mr. Quin's method of fault finding might be of service in such an occurrence as this:—"An extraordinary electrical phenomenon was noticed at Blackpool last night. By some means the Market Hotel, Lytham Street, became charged with electricity, it is supposed in consequence of a probable leakage from one of the electric supply mains in the street. The house front is entirely built of stone, and it is singular that this should have acted as a conductor. Water was thrown on the lower part of the building, but this only interrupted the current. For several hours the hotel was besieged by a crowd of persons, many of whom were curious enough to prove the fact by placing their hands on the building and receiving shocks similar to those from an electric battery."

Bootle.—The Watch Committee of the Corporation have since February last been engaged with Mr. Thomas L. Miller, electrical engineer, in preparing a scheme for supplying the borough with electric lighting. The Committee's third report has been submitted to the Town Council. It explains that Mr. Miller's first scheme was for 8,000 lamps of 8 C.P., but the Committee deemed it advisable to obtain an amended scheme for providing 18,000 lamps, the cost of which, exclusive of buildings and road works, was estimated at £31,000. However, on further consideration, the committee recommend the adoption of the smaller scheme for 8,000 lamps. The Committee have come to the conclusion that the Corporation's vacant land adjoining the wharf in Pine Grove affords the most suitable site for the generating station. Mr. Miller's scheme has been submitted for examination to Mr. A. B. Holmes, electrical engineer to the Liverpool Corporation. The Committee regard Mr. Holmes's report as satisfactory, and as fully justifying them in recommending Mr. Miller's scheme for adoption by the Council. They urge the Corporation to proceed with the scheme at once, pointing out that their powers under the Provisional Order will expire next month. Mr. Miller's scheme provides for a supply of electrical energy on the three-wire direct current system at a pressure of 220 volts at consumers' terminals. The generating station to be placed on land adjacent to the destructor, but independent of the existing destructor buildings and plant. The present capacity of the plant shown on the plans submitted is 300 kilowatts, capable of dealing with 7,500 to 8,000 lamps of 8 C.P. connected to the mains. With possible extensions, the capacity could be increased to 1,500 kilowatts, or about 60,000 lamps of similar power. For public lighting the engineer recommends 16 arc lamps for Stanley Road (at an estimated cost for mains and lamps of £1,296), and incandescent lamps, with reflectors on existing lamp-posts, from 45 to 50 yards apart in other streets. The possibility of extension of plant to provide current for tramway purposes has been kept in view, and by putting down an extra steam dynamo the capacity of the engine house plant would be doubled for about £2,000. In the estimate appended, the capacity of the feeder mains is for about 20,000 lamps of 8 C.P. connected to the mains, the cost being £5,846, for 25,000 £6,285, and for 30,000 £6,965, with a decreasing price for extensions to the distributing network. The estimate puts down £11,000 for engine house plant, £5,846 for feeders, £4,630 distributors, £500 service connections, £350 meters, and other items for feeder, network, and service boxes, tools, alterations at the Town Hall, &c., bring the total to £23,152. To this total the Committee add spares £540, return wire from feed point No. 3 £790, and engineer's commission £1,220, making a total of £25,612. The erection of the engine house and the excavation and reinstatement of the roads have been left by the Committee to the borough surveyor, who estimates the cost of these works at £8,695, and allowing £693 for contingencies, the Committee arrive at the total of £35,000.

Bradford.—The Gas and Electricity Supply Committee will recommend the City Council to apply to the Local Government Board for authority to borrow an additional sum of £50,000 required for the extension of the electricity supply. Alderman F. W. Jowett proposes also "That the Parks and Cemeteries Committee be requested to consider the subject of lighting by electricity the following portions of Lister Park, viz., the carriage drive from the principal entrance in Manningham Lane to the hall, in front of the band-stand, and the conservatories, and that the Committee be authorised to carry out the work."

Burnley.—The Council has resolved to extend the mains down certain thoroughfares at a cost of about £2,000.

Cardiff.—The following figures are given by a Cardiff paper showing the increased cost of lighting the Market by electricity, as compared with gas:—In 1894, when gas was the only illuminant, the lighting expenses for the year were £206 13s. 2d., but in 1896, when electricity was introduced, the cost rose to £491 6s. 1d., with £68 odd for gas as well, making a total increase of £357 odd. The paper in question does not say how much more light is used.

Cheltenham.—Minutes passed by the City Council, last week, showed that the electrical engineer had reported that arc lamps had been suspended in the Promenade from the eight pairs of pillars then erected, and had been switched on for trial runs. He also reported that additional condensing plant would be required at the electricity works about the end of November.

Chiswick.—The Imperial Electric Light and Power Company, Limited, has written to the District Council notifying its intention to apply for a provisional electric lighting order. The letter is to lie on the table.

Clacton.—The Council has asked for further particulars before consenting to the proposed application of the Imperial Electric Light and Power Company for a provisional order.

Colchester.—The Council has approved the proposal of the Electric Construction Company to extend the guarantee in respect of the engines to four years, subject to the period for guarantee of feeders and cables being reduced to four years, and an arbitration clause being included in the contract. The tender of Messrs. Stanford & Co. at £167 15s. for supplying and fixing a cast-iron water tank at the lighting station has been accepted.

Colne.—The Council will oppose the intended applications of Messrs. Crompton and the Electric Supply Corporation for provisional orders.

Country House Lighting.—An electric light installation has just been completed at Selaby, Gainford, near Darlington, the residence of Charles E. Hunter, Esq. The house is lighted throughout, also the stabling and out-houses, &c. The plant comprises a 25 H.P. steam boiler and engine and a belt-driven shunt-wound dynamo, and a battery of accumulators comprising 53 cells of 33 plates each. The engine and accumulator house is situated about 100 yards from the hall, the cable being carried underground. The work was entrusted to Messrs. Thos. G. Usher & Co., electrical engineers, Newcastle-on-Tyne.

Dover.—The Electric Light Committee have revised their scale of charges for current from July 1st. The Brighton system has been adopted. The price for current supplied will be, as at present, 7d. per unit for the first 360 hours' use in each half-year, or about two hours average daily consumption of the maximum demand at any time, and all current in excess of such quantity will be charged at 3½d. per unit instead of 5d. as hitherto.

Dublin.—The following comments from the *Freeman's Journal* show the financial condition of the electricity undertaking here.—"The Electric Lighting Committee have prepared a report dealing with the financial results of the working of the electric lighting system for last year. The statement of the City Accountant shows that the gross income for the year 1896 was £11,747 0s. 5d., and the expenditure (not including interest on the loan) amounted to £8,990 10s. 6d., leaving a surplus of revenue over expenditure of £2,756 9s. 11d., which is equivalent to 4·7 per cent on the capital expenditure to the end of the year, viz., £58,029 18s. 2d. This surplus was applied to the payment of 3½ per cent. interest on the loans obtained for the erection of the electric lighting plant, and for this purpose £1,073 11s. 9d. was required. A sum of £81 5s. 1d. was written off the assets shown in the accounts for 1895, leaving a balance of £1,073 11s. 9d. The amount required for the repayment of loans was £2,213 6s. 8d. for last year, and the balance of the surplus, £1,073 11s. 9d., having been applied to that purpose, it would appear that there was really a deficit on the year's working of £1,139 14s. 11d. to be discharged out of the rates. This deficit is provided for by the special rates raised for electric lighting purposes in 1891 and '92, amounting to £6,636 9s. 7d. This fund, however, is becoming rapidly exhausted, while the demands upon it do not appear to be diminishing in any appreciable degree. In '91 and '92, when the station was only working for one quarter, it was reduced by £1,199 12s. 10d. In '93 the demand on it was £990 12s; in '94, £624 14s. 1d.; in '95 the amount rose to £1,316 1s. 2d., while last year the substantial sum of £1,139 14s. 11d. had to be paid out of the fund. The amount now remaining available for this purpose is only £665 14s. 7d., and as the Superintendent of Electric Lighting, Mr. Ruddle, points out in a report to the Committee that alterations in the system are 'absolutely necessary,' and that they will involve 'heavy expense,' the citizens may look forward in the estimates this year to a considerable call upon them for electric lighting. It is right, however, to point out that the Committee have done a great

deal in the way of repaying the loans obtained for the purpose of establishing the system. Up to December 31st last, the total amount of loans repaid was £7,893 6s. 8d.; the amount paid in interest on loans was £6,077 19s. 8d.; the amount transferred to the depreciation account was £1,000, making a total of £14,971 6s. 4d. The amount so far paid out of the rates comes to £5,270 15s., so that the amount paid out of income is £9,700 11s. 4d. The Committee allotted nothing to the depreciation account last year. 'In consequence of serious breakdowns that have lately occurred in the street mains,' the Committee directed Mr. Ruddle to visit the various English cities and report on the systems in operation there. Mr. Ruddle gives a long technical report on the subject, and he winds up with the following significant statement:—'These alterations will mean a heavy expense, but I consider them to be absolutely necessary if we are to have a reliable system of supply.'"

Durban.—In a short article on the electric lighting of Durban the *Financial News* says that it is close upon three years ago that the plan was first mooted, but before committing themselves to a definite policy the Town Council determined to place themselves in consultation with Mr. Preece. Three schemes were submitted by Mr. F. H. Hadfield (electrician to the Council), and the one selected by Mr. Preece was finally adopted. The Corporation have combined their sewerage and electric lighting machinery in one station at Durban Point, and have a battery of boilers common to both services, whilst using separate engines. Mr. Hadfield had placed at his disposal a sum of £25,000 to provide an installation of electrical plant capable of supplying electricity for 60 2,000 candle-power arc lamps and 2,500 16 candle-power incandescent lamps; and it was anticipated when the mail left that the installation would be complete and every lamp available on Jubilee night.

Edinburgh.—The Electric Lighting Committee will recommend an extension of the low tension continuous current mains from Crosscauseway to Salisbury Place, at a probable cost of £1,200.

Hammersmith.—The Vestry is organising an exhibition of electrical fittings, heating and cooking appliances, &c., to be held at an early date in the new Town Hall.

Hampstead.—The Lighting Committee has been going into the question of street lighting, and has now been empowered by the Vestry to conduct experiments for incandescent electric lighting for the purpose, and to report the result after three months' working. The mains are to be extended along several thoroughfares. The charge for motive power current during the day will in future be 2½d. per unit.

The Lighting Committee has recommended that a sum of £200 should be granted (without admitting any liability) to the widow of the labourer named Henry White, who was killed while working in a "transformer" chamber.

Hastings.—The Old Town Conservatives held a meeting last week to discuss the proposed purchase of the electric light company's undertaking.

When the purchase of the works was decided upon by the Corporation, it was agreed that the plant on the Front Line should be purchased at a valuation. The price asked some weeks ago was £4,100, which the Public Lighting Committee considered excessive, and it was resolved to offer £3,200, which the company refused to accept. At a subsequent meeting of the directors of the Electric Light Company last week, it was decided to sell at £3,200. Arrangements are being made for the immediate taking over of the Front Line plant, as the Council has its own machinery in Waterworks Road, and mains are being laid down Queen's Road which will connect with those on the Front.

Hawick.—The Town Council has received an intimation from the Imperial Electric Light and Power Company, that they intend to apply for a provisional order for electric lighting in Hawick. It was agreed to ask for further information before the Council gave their consent.

Hemel Hempstead.—The Guardians received a letter from the Bedford Electric Lighting Company, Limited, informing the Board that they were applying to the Local Government Board for a Provisional Order, but the Guardians declined to give their consent.

Islington.—The Vestry has increased the salary of Mr. Charles H. Yeaman, the assistant electrical engineer, from £160 to £200 per annum. Mr. Yeaman's services in connection with the undertaking were very highly spoken of.

Lambeth.—The London County Council having drawn the attention of the Board of Trade to the fact that under the order confirmed by the Board of Trade in connection with the transfer of the Lambeth Electric Lighting Order, 1892, to the South London Electric Supply Corporation, the Council have no power of approval or disapproval in regard of proposed works, the Board of Trade have informed the County Council that every provisional order granted in future to a local authority in London, will contain a provision that notice of a proposed transfer of the powers must be given to the London County Council, so that such a position of affairs as has arisen in connection with the transfer of the Lambeth order shall not again occur.

Larne.—Tenders for lighting the town were invited for the 21st ult., but at that date none were received. Since then, however, the Larne Electric Light Works Company, of London (the late contractors), had sent in a tender. They propose to light the town with electric light for three years from August 1st next, by means of arc and incandescent lamps, at the following rates: Each arc lamp of 1,200 C.P. nominal (450-watt lamps), £11 per annum; each arc lamp of 600 C.P. (225-watt lamps), £7 10s. per annum; each incandescent lamp of 32 C.P., £4 10s. per annum; each incandescent lamp of 25 C.P., £3 per annum; each incandescent lamp of 16 C.P., £2 per annum. It was ultimately decided that the Larne Electric Light Works, Limited, be requested to inform the board whether they are willing to enter into an agreement to light the town with electric light for one year from August 1st, 1897, on the same conditions as those existing for the last three years, no extension of the present lamps to be required.

Liverpool.—Someone has written to the Electric Lighting Committee, stating that he has discovered a scheme whereby the greater part, if not the whole, of the city of Liverpool could be automatically supplied with electric light. He was prepared to give the city the benefit of the idea upon a certain consideration. The communication was allowed to lie on the table.

London.—Two London Electric Lighting Provisional Order Bills have received the approval of a Select Committee of the House of Lords, presided over by Lord Heneage. One was an order to enable the County of London and Brush Provincial Electric Lighting Company to supply electricity in a portion of the Holborn district, which is at present supplied by the Metropolitan Electric Supply Company. One of these companies supplies electricity on the alternating current system, and the other on the continuous current system. It has been the general policy of the Government to allow two companies to compete if supplying on the separate systems, and this policy the Committee have upheld. In the other case the provisional order was to enable the Vestry of Newington to supply electricity in their district, and it was opposed by local ratepayers. The Committee held that the petitioners had no *locus standi*.

London.—The London County Council, on Tuesday, agreed to establish a system of electric lighting for the Victoria Embankment and bridges. The Highways Committee was, however, instructed to submit further details of the installation. We published the committee's recommendations last week.

Mitchelstown.—The Board of Guardians has resolved upon electricity for public lighting. At a meeting of the Guardians on Saturday, a scheme was adopted, under which it is proposed to light the town at night with 42 incandescent electric lamps. The motive power is to be a turbine wheel worked by water—wheel and water to be provided by the Countess of Kingston, Mitchelstown Castle, who will make a contract with the Guardians to keep the light going for a period of 22 years from sunset to midnight every night in the year. The Guardians are to supply all the plant and erect it, save the turbine wheel and the dynamo. The plant is to be the property of the Guardians, but to be kept in working condition for and during the term of contract for a sum of £70 per annum. Arrangements will be made also for private lighting.

Motherwell.—The Board of Trade has expressed its willingness to delay revocation of the Council's provisional order on the understanding that the works would be proceeded with within 12 months. The Water and Lighting Committee will consider fully and report.

Mold.—The Great Western Electric Light and Power Company has notified the District Council that it proposes to apply for a provisional order for lighting the district.

Montrose.—The Asylum House Committee have accepted the offer of £600 2s. by Messrs. Anderson & Munro, electricians, Glasgow, for the electric installation at Sunnyside Asylum, the work to be completed within two months. The committee had also considered the serious condition of the present installation, but agreed to let the question of what should be done in case it broke down before the new system was introduced lie over until the report of Mr. T. Young, C.E., had been received.

Newington.—The Select Committee of the House of Lords appointed to consider the Electric Lighting Provisional Orders have refused to allow the petitioners against the order for Newington to have any *locus standi* to be heard against the Bill which has been sent to Parliament by the Board of Trade for confirmation.

Norwich.—Messrs. Bullard & Sons, Limited, in the large new mineral water manufactory they have had erected and fitted at Norwich, have the motive power entirely supplied by electricity. The dynamo was supplied by Messrs. Laurence, Scott & Co.

The Norwich Electricity Company, Limited, intend to make application to the Board of Trade, this year, for a provisional order, authorising the supply of electricity for public and private purposes within the parishes of Sprowston, Old Catton, and Hellesdon.

Onchan (I.O.M.).—The electric light installation was inaugurated on Tuesday last.

Paddington.—The County of London and Brush Provincial Electric Lighting Company, Limited, have notified the Paddington Vestry that they intend making application for a provisional order to supply electricity for public or private purposes in Paddington.

Rochester.—The Town Council, who have for some time past had the electric light in the Council Chamber, have now decided to extend it to the Guildhall, and have given orders to Messrs. Stevens & Barker for the fixing of two brass electroliers.

Rotherhithe.—The County of London and Brush Provincial Electric Lighting Company have given notice of their intention to make application to the Board of Trade for a provisional order for the parish of Rotherhithe.

THE TELEGRAPH MANUFACTURING CO., Ltd.

ELECTRICAL AND TELEGRAPH ENGINEERS.

MANUFACTURERS and CONTRACTORS to the British ADMIRALTY, POST OFFICE, WAR OFFICE, all British RAILWAY Co.'s, ELECTRIC LIGHT Co.'s the NATIONAL TELEPHONE Co., COLONIAL GOVERNMENTS, MUNICIPALITIES, &c., &c.

For ELECTRIC LIGHT — Cables and Wires; Vulcanised Rubber, Lead Covered, Armoured; Mains, Concentrics, Flexible Cords.

TELEPHONE — Instruments Exchange Equipments; Cables, Wire Batteries, Insulators, Switchboards for Private Installations, Gutta Percha Wires.

TELEGRAPH — Postal Railway, Fire Alarm and Police Equipments Railway Signals and Blocks; Iron Poles, Insulators, Batteries, Cables, Gutta Percha wires

Works: HELSBY & 16, NEWINGTON, LIVERPOOL. Head Office: HELSBY, nr. Warrington, England.
Branch Offices: 11, Queen Victoria Street, LONDON, E.C.; 2, Parsonage, MANCHESTER; and 30, Hope Street, GLASGOW.

5461

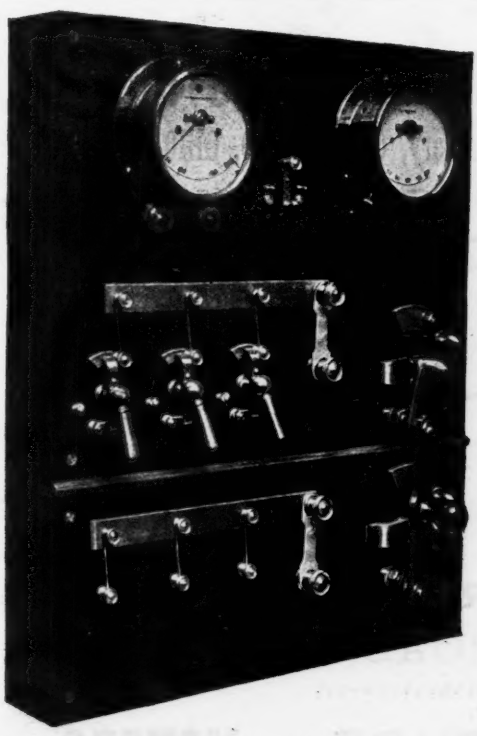
Telegraphic Addresses: "VERITY, BIRMINGHAM." "VERITY, LONDON."

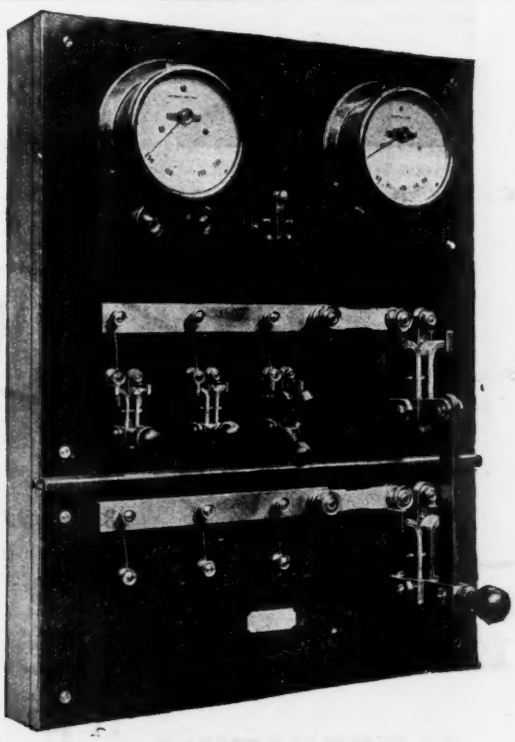
VERITYS, LTD.,

TRADE MARK

ELECTRICAL FITTINGS AND ACCESSORIES MANUFACTURERS,

PLUME WORKS, ASTON, BIRMINGHAM. 31, KING STREET, COVENT GARDEN, LONDON.





ORDER ALL SWITCHBOARDS FROM

VERITYS

They have the largest assortment and the greatest facilities for manufacturing.

SPRING CONTACT, DIAMOND, or ASTON Types of Switches, and all Fuse Terminals of Veritys' Patent Spring Nut Pattern, which ensures absolutely tight contact under all conditions.

WANTED, a 20-H.P. Combined Engine and Dynamo Set, Secondhand (must be by well-known makers, and in perfect working order), as additional auxiliary engine and dynamo for our New Works. Dynamo 115 volts. Apply to Plume Works, Aston.

6925—6

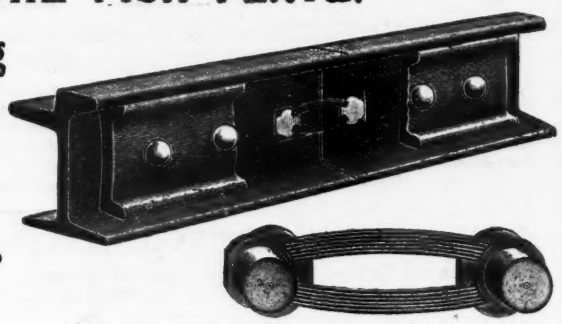
THE PROTECTED RAIL BOND

PLACED UNDER THE FISH PLATE.

Flexible to Vibration and Yielding to Contraction and Expansion.

SOLID COPPER TERMINALS CAST-WELDED ON TO COPPER WIRES.

We furnish Screw Welders for Fastening Bond to the Rail. Send for Catalogue and Prices.



COMMUTATOR SEGMENTS.

DROP FORGED AND ROLL DROP.

ALL STYLES AND SIZES.

THE FOREST CITY ELECTRIC CO.

Main Office and Factory, CLEVELAND, OHIO, U.S.A.

Cable Address:—"ROLLDROP." **Foreign Catalogue in 5 Languages.**

Telegraphic Address — "GALVANOSCOPE, LONDON

THE ELECTRICAL CO., LTD.

SOUTH COAST AGENCY:

3, North Street, Quadrant, BRIGHTON.

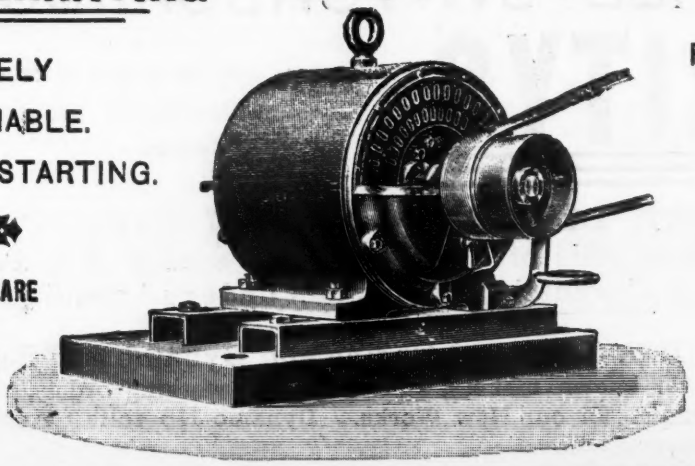
Telephone:— No. 35,028, GERRARD.

ONLY ADDRESS:

122-124, CHARING CROSS ROAD, LONDON, W.C.

ALTERNATING "E.C." TYPE. MOTORS.

ABSOLUTELY RELIABLE. SELF-STARTING.



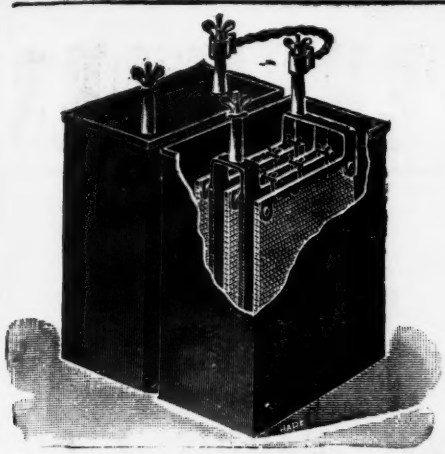
FOR ANY PERIODICITY AND VOLTAGE.

From $\frac{1}{5}$ to 70 B.H.P.

OUR MOTORS ARE RUNNING ALL OVER THE UNITED KINGDOM.

TESTIMONIALS ON APPLICATION.

6879



CARRIAGE TYPE "C" 5.—Total weight, 23 lbs.; Capacity, 80 ampere hours at a discharge rate of 20 amperes. Overall Dimensions, 7-in. × 4-in. × 13-in. 100 ampere hours at half rate discharge.

THE LAMINA ACCUMULATOR

The Only Suitable Cell for AUTO-CARS.

Plantè Principle, YET lighter than any paste cell in existence

Write for New List and Full Particulars to the

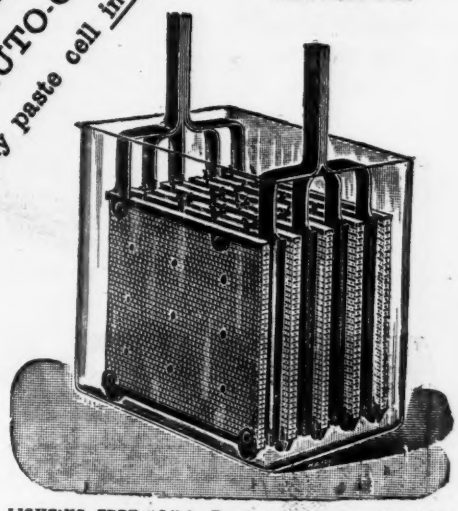
LAMINA ACCUMULATOR

(Ellison's British Patents)

SYNDICATE, LIMITED,

Broad Street Avenue,

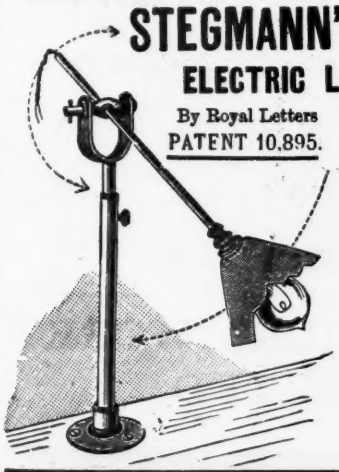
LONDON E.C.



LIGHTING TYPE "A" 9.—Total weight, 71 lbs.; Capacity, 330 ampere hours at a discharge rate of 40 amperes. Overall Dimensions, 8-in. × 10½ in. × 12-in. 430 ampere hours at half rate discharge a411

ELECTRIC SUPPLY STORES. ESTABLISHED 1885.

STEGMANN'S MOVABLE ELECTRIC LIGHT STANDARD,



By Royal Letters PATENT 10,895.

FOR LABORATORIES, WORKSHOPS, &c.

With this Standard the light can be thrown in any desired direction.

Exhibited, by Appointment, at the Royal Institution of Great Britain.

G. STEGMANN,

Electrical Engineer,

69, St JOHN'S HILL,

Clapham Junction

LONDON, S.W.

Telegrams:—"Ampere, London."

1024

STONEWARE CONDUITS AND INSULATORS

For ELECTRIC LIGHT MAINS

SUPPLIED RECENTLY FOR

GLASGOW, PRESTON, DUNDEE, NORWICH, WESTMINSTER, ST. PANCRAS, RICHMOND, &c.

JAS. STIFF & SONS,

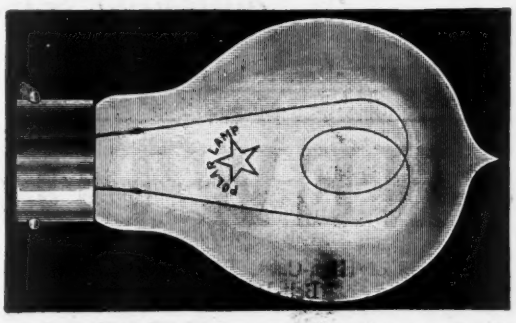
LAMBETH LONDON. S.E.

LARGE STOCKS OF POROUS CELLS, BATTERY JARS, TELEGRAPH AND TELEPHONE INSULATORS, VITRIFIED LEADING-IN TUBES, &c., &c., &c.

1046

THE

"POLAR" LAMP



High efficiency. Long life. Moderate price.

CARBONS FOR ARC LIGHTS,

Dynamo Brushes, and Electrolysis.

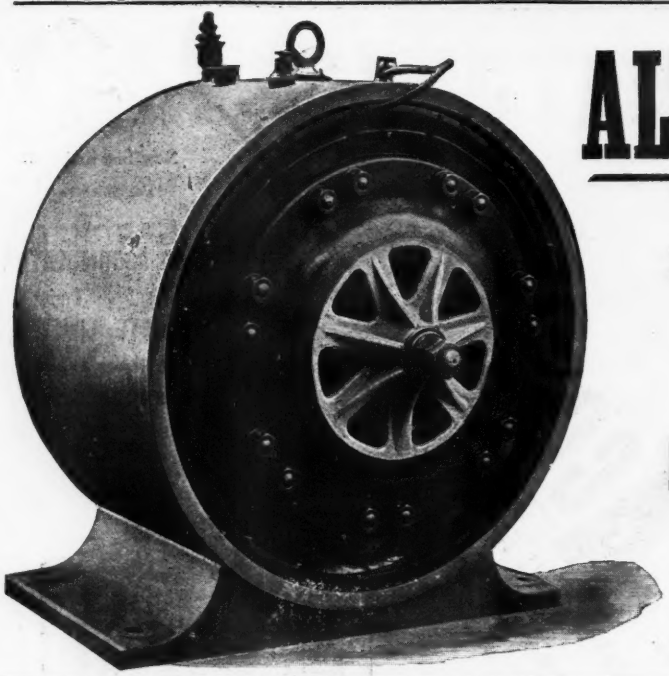
AMBROIN,

The New Insulating Material.

SOLE AGENT:

OSCAR SCHÖLZIG, DASHWOOD HOUSE, LONDON. E.C.

a208



ALTERNATORS

FOR

Laboratories,
Testing and
Special Purposes.

PYKE, HARRIS & CO.,

LIMITED,

34, New Tothill Street,
WESTMINSTER.

Telegraphic Address: "MUIRHEAD, LONDON."

MUIRHEAD & Co.,

ELECTRICAL ENGINEERS.

MANUFACTURERS OF THE WELL KNOWN

"WESTMINSTER" DYNAMOS

HOPKINSON'S PATENT AUTOMATIC

BATTERY REGULATING SWITCHES.

STANDARD CELLS.—Dr. Muirhead's Patent Portable Form, with Certificate of Value.

NOTICE.—Removal of Works to ELMER'S END, KENT, adjoining S.E. Railway Station.

All Letters to be addressed to our City Office, 54, OLD BROAD STREET, E.C. a878

The NEWTON ELECTRICAL WORKS, LIMITED.

Makers of High-Class, Direct-Coupled, or Belt-Driven

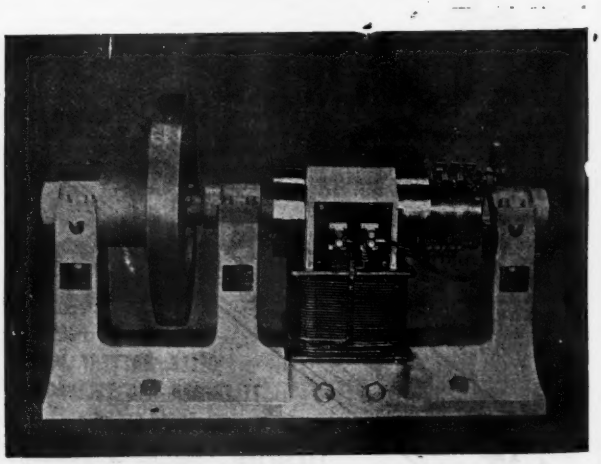
DYNAMOS & MOTORS,

Fitted with Improved Patent Self-Oiling Bearings, Adjustable or fixed Field-Magnets.

ALSO MANUFACTURERS OF

ALTERNATORS AND TRANSFORMERS.

CORRESPONDENCE SOLICITED AND ESTIMATES GIVEN.



Head Office and Works:— **TAUNTON, ENGLAND.** Telegrams: "Arc, Taunton." a885

ELECTRICAL ACCESSORIES

ELECTRICAL ACCESSORIES,
SWITCHES, CUT-OUTS,
DISTRIBUTING FUSE BOARDS
CEILING ROSES,
WALL PLUGS, &c.

MANUFACTURED BY

GEBRUDER JAEGER,

FOR

A. VANDAM & CO.,

SOLE LICENCEES,

39 VICTORIA STREET. LONDON S.W.

ARC LAMPS,
INCANDESCENT LAMPS,
WROUGHT IRON AND BRASS
ELECTRIC FITTINGS,
WROUGHT IRON GATES AND
RAILINGS.

a502

EASTON, ANDERSON & GOOLDEN, LIMITED.

HEAD OFFICE:—ERITH IRONWORKS, ERITH, Kent.

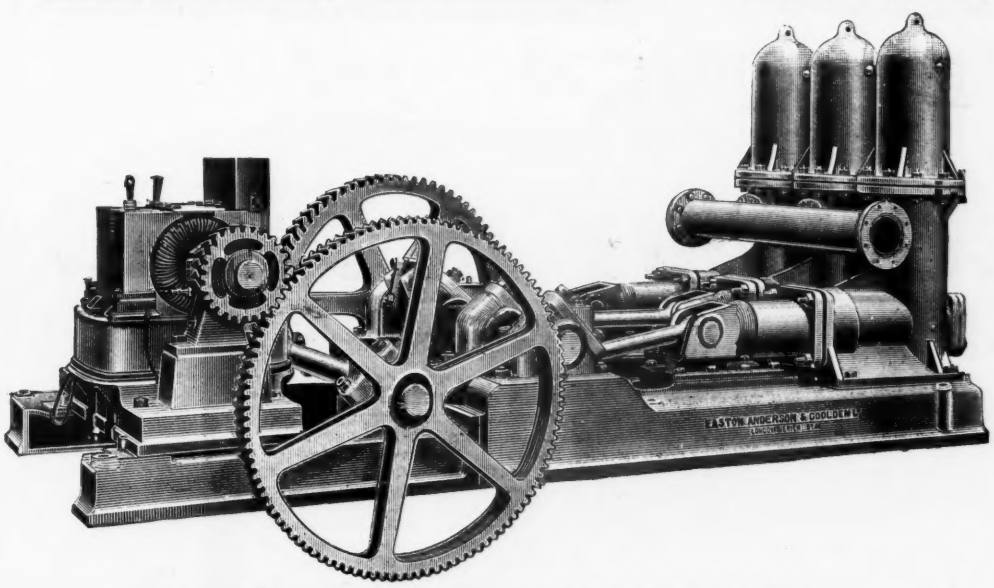
Telegrams:—"EASTONS ERITH." Telephone:—DARTFORD, No. 4.

LONDON:—Broad Sanctuary Chambers, Broad Sanctuary, S.W.

Telegrams:—"EGYPTIAN, LONDON."
Telephone:—545 Westminster.

NEWCASTLE-ON-TYNE:—2 St. Nicholas Buildings.

CARDIFF:—Western Mail Buildings.



MOTOR AND THREE THROW PUMP FOR
THE MAY CONSOLIDATED GOLD MINING COMPANY.

ELECTRIC MINING MACHINERY.

PATENT ENCLOSED MOTORS FOR COLLIERIES.

ELECTRIC COAL CUTTING.

ELECTRIC LIGHT & POWER.

HIGH SPEED ENGINES.

ELECTRIC LIFTS AND CRANES.

ELECTRIC TRACTION.

BOILERS.

1268

PRESSSPAHN

THE INSULATING MATERIAL USED BY THE LEADING MAKERS OF

DYNAMOS, ALTERNATORS, AND TRANSFORMERS.

(MADE IN SHEETS 60 cm. by 80 cm., THICKNESS from 0·2 m/m. to 4 m/m.)

Particulars and Prices can be obtained from

THE INTERNATIONAL TRADING COMPANY,

CORNWALL BUILDINGS, 35, QUEEN VICTORIA STREET, LONDON, E.C.

Sole Agents in the United Kingdom for Dr. Forke & Co., Neuhammer.

1083

BROCKIE-PELL ARC LAMPS

Can be easily altered to suit any circuit, Continuous or Alternating.

ALTERNATING ARCS

FOR

HIGH OR LOW TENSION CIRCUITS,

As used in Regent St., London; Hyde Park, &c.

Trade Mark—"BROCHIPEL." Telegrams—"Illuminers, London."

BROCKIE-PELL ARC LAMP, LTD.,

97, Queen Victoria St., LONDON, E C.

ECONOMY IN FUEL.

The CAMBRIDGE ELECTRIC SUPPLY CO., LTD.,
Thompson's Lane, Cambridge, May 5th, 1897.

Messrs. MELDRUM BROS., MANCHESTER.

YOUR FURNACES.

Dear Sirs,—At the end of the month's trial, April 30th, you will be glad to hear that your furnace has fulfilled the guarantee: the amount per unit generated in coal has been reduced by 17½ per cent., and per unit sold 30 per cent. The absence of smoke is very marked, excepting a slight amount when the boiler has been forced hard: we have on several occasions obtained an evaporation of over 8,000 lbs per hour (boiler being two-flue Lancs., 30 ft. by 7 ft. 6 in.). There is little doubt that the Board at their next meeting will decide to add these furnaces to the two remaining boilers.

(Signed) JOHN H. BARKER.

Note.—Since the above letter was written we have received the order for the two remaining boilers.

MORE STEAM.

LESS COST.

LESS SMOKE.

5000 WORKING.

WRITE FOR CATALOGUE AND OTHER TESTIMONIALS.

MELDRUM BROS.,

Atlantic Works,

MANCHESTER.

ALSO AT—

London.	Liverpool.
Leeds.	Birmingham.
Glasgow.	Newcastle on-Tyne.
Paris.	New York.
Bombay.	Calcutta.
Tokio.	Sydney.

8610

UNIVERSAL ELECTRICAL DIRECTORY

(J. A. BERLY'S). **6s.** 1897.

YOUR TRAVELLER MUST HAVE IT.

THE GEOGRAPHICAL ARRANGEMENT OF NAMES IN ENGLAND, SCOTLAND IRELAND, AND WALES, WILL ENABLE HIM TO GET ORDERS AND WILL SAVE HIM FROM PORING OVER LOCAL DIRECTORIES, WHICH ARE VERY OFTEN INACCURATE.

PRICE ONE SHILLING.

DOMESTIC ELECTRIC LIGHTING,

TREATED FROM THE CONSUMERS' POINT OF VIEW.

BY

ED. C. DE SEGUNDO, ASSOC.M.INST.C.E.

POST FREE, 2s. 6d. WITH 34 ILLUSTRATIONS

OZONE:

ITS COMMERCIAL PRODUCTION AND ITS APPLICATIONS.

By EMILE ANDREOLI.

POPULARLY WRITTEN AND FULLY ILLUSTRATED. POST FREE, 1s.

THE STRANGE HISTORY OF A DYNAMO.

By T. E. GATEHOUSE.

Should be read by all interested in the production of electricity. An excellent gift for schoolboys.

ILLUSTRATED. 3s. 6d. POST FREE.

POLYPHASED ALTERNATING CURRENTS,

By E. HOSPITALIER.

CONTENTS:—Introduction. I. Triphased Currents. Chapter 1. Generation. Chapter 2. Transformation. Chapter 3. Applications, Electric Lighting, Motors. Chapter 4. Multiple Transformers.

II. Diphased Currents. Chapter 1. Generators. Chapter 2. Transformers. Chapter 3. Motors. Chapter 4. Multiple Transformers. Appendix A. Appendix B.

---

59 Illustrations. Post Free, **2s. 6d.**

PHOTOGRAPHIC & OPTICAL ELECTRIC LAMPS.

By RANKIN KENNEDY.

A Treatise for Photographers, Photo-Electric Printers' Etchers and Engravers, and including Apparatus for Copying Purposes for Engineers and Architects.

THE ONLY WORK IN EXISTENCE TREATING ON THIS SPECIAL SUBJECT.

Any of the above Books can be had, Carriage Paid, by sending a remittance for the price indicated to—

H. ALABASTER, GATEHOUSE & CO., 22, Paternoster Row, London.

THE

GENERAL ELECTRIC CO., LD.,

MANUFACTURERS OF

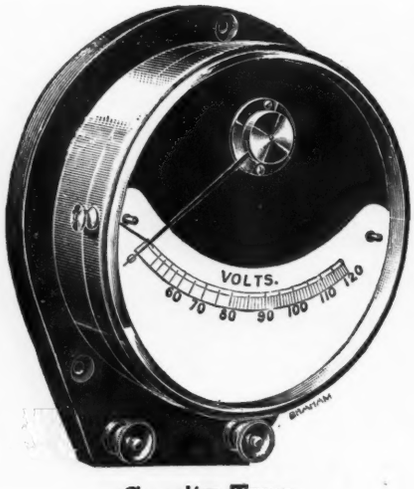
ALL CLASSES OF ELECTRICAL INSTRUMENTS.

"STANLEY" PATENT

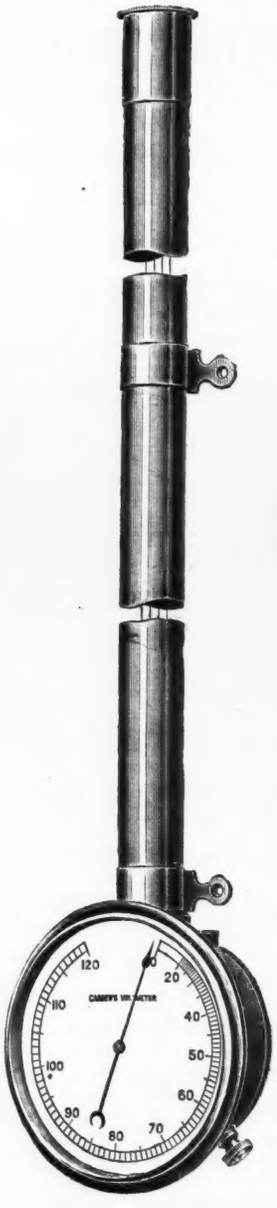
AMMETERS AND VOLTMETERS

CELL-TESTING VOLTMETERS.

PORTABLE VOLTMETERS, Reading to 120 volts.

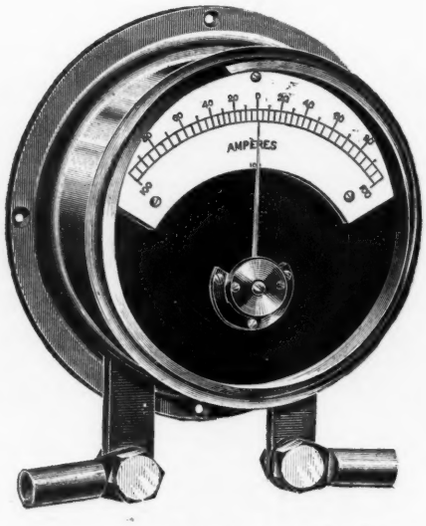


Gravity Type
AMMETERS & VOLTMETERS
For Central Station Work.



LOW READING AMMETERS.

MILLIAMPERE METERS And all Special Readings, TO ORDER.



Permanent Magnet and Spring Control
AMMETERS & VOLTMETERS
For use on Ships, Motor Cars, &c.

ELECTRICITY METERS.

GALVANOMETERS.

CARDEW VOLTMETERS FOR DIRECT OR ALTERNATING CURRENTS.

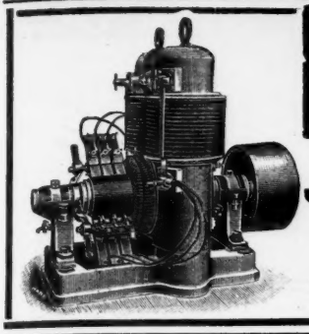
HEAD OFFICES, WAREHOUSES AND SHOWROOMS—
69, 71, & 88, Queen Victoria Street, LONDON, E.C.

Works— Peel Works, Adelphi, SALFORD. Brook Green, HAMMERSMITH. CLERKENWELL.

Branches— 45, Chapel Street, Manchester. 71, Waterloo Street, Glasgow. 39, Corporation Street, Birmingham. 13, Westgate Road, Newcastle-on-Tyne.

ALTERNATOR, about 8 amps. 100 volts, wanted; also Motor, direct current 100—110 volts, about 1 H.P.—Price and full

FOR SALE BY PRIVATE TREATY.
ELECTRIC LIGHT PLANT, &c.



THE "CASTLE" SLOW SPEED.
HIGH EFFICIENCY.
J. H. HOLMES & CO.,
NEWCASTLE-ON-TYNE,
AND
17 SOHO SQUARE W.
DYNAMOS
2662

THE ELECTRICAL REVIEW.

PUBLISHED EVERY FRIDAY, PRICE 4d.
Office: 22, PATERNOSTER ROW LONDON.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY

NOTICE TO ADVERTISERS.

The following are the LATEST times up to which Advertisements can be received for publication in current week's issue:—

New Advertisements, or Alterations to existing ones, Wednesday 2 p.m.
Small Announcements for middle pages, Thursday 2 p.m.

TELEPHONE No. 15,077 Telegrams: "INDICES," LONDON.

WHEATLEY KIRK, PRICE & GOULTY

(ESTABLISHED 1860).

Electrical Auctioneers, Valuers,
AND ARBITRATORS.

Average Annual Valuations exceed £1,500,000 Sterling.

49, QUEEN VICTORIA STREET, LONDON E.C.
a2391

CHEAP PREPAID ADVERTISEMENTS,

Relating to *Situations Vacant, Situations Wanted, Businesses Wanted, Businesses for Sale, Patents for Sale, Specific Articles of any kind Wanted, or for Sale or Exchange, are inserted at the rate of* ONE PENNY *Per Word* (*minimum* 1s.).

Three consecutive Insertions for the Price for Two.

**** This Scale does not apply to Trade Advertisements, terms for which can be had on application.

SITUATIONS VACANT.

Where Advertisments are to be answered to a given number, letter, or *nom de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.

Original Testimonials should never be sent.

ASSISTANT and Junior wanted for electrical testing in electro-chemical laboratory.—Full particulars to 1,305, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1305

AN ASSISTANT required by a firm in Belfast for showrooms and to take charge of stocks, must be thoroughly reliable and a knowledge of the business and good address necessary.—Apply in own handwriting, giving experience, and salary expected, to 1,301, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1301

DRAUGHTSMAN (Junior) wanted, accustomed to switch work and small electrical work.—Apply, stating experience and salary required, to SECRETARY, Electric Insulation Syndicate, Limited, Cardiff. 1306

ELECTRICIAN, young, wanted in meter testing department.—State age, experience, and salary required, to CHAMBERLAIN AND HOOKHAM, LTD, New Bartholomew St., Birmingham. 1304

METER TESTING.—Assistant required for the meter-testing department.—Apply by letter, stating qualifications to CHELSEA ELECTRICITY SUPPLY COMPANY, LTD., 19, Cadogan Gardens, S.W.

PREMIUM PUPILS.—Large electrical manufacturing works, near London, have several vacancies.—Address 1,278, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1278

STOREKEEPER, who has been used to electrical store, wanted at once, for an electrical engineering works in the North of England.—Apply, stating age, experience, and salary required, to 1,290, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1290

WANTED.—A Good Jointer used to overhead cables. Permanency.—Apply 1,298, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1298

WANTED.—First-class Armature Winder, accustomed to gramme and drum armatures.—Address, with full particulars as to experience, wages, &c., CLAYTON FOUNDRY CO., LTD., Clayton, Manchester. 1286

VULCANITE.

HARBURG INDIA-RUBBER C. COMPANY.
London Warehouse: F. WINTER, 138, London Wall, Wood St., E.C.

EBONITE.

1710

YOUNG MAN Wanted by Manufacturing Electrician as Traveller and Confidential Assistant. Preference to one able to invest small capital with view to ultimate partnership.—Address, 1,235, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1235

SITUATIONS WANTED.

Where Advertisements are to be answered to a given number, letter, or *nom de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.

A.I.E.E. will shortly be open for an appointment as Managing Engineer to a good firm, 10 years' experience; well up in specifications and estimating. Can influence very large contracts in the North of England.—Reply in first instance 1,288, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1288

ELECTRICAL ENGINEER (24) desires re-engagement as Assistant in central station (low tension) or as Assistant Electrician. Highest testimonials.—1,226, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1226

ELECTRICIAN (young) wants situation to take whole or part charge of electric light installation, or as an Assistant in central station, do own repairs, good armature winder.—"W. W.," 31, Ossington Street, Bayswater, W. 1256

ELECTRICIAN (working) requires situation to take charge of installation work, experienced in the fixing of complete plant.—1,302, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1302

ENGINEER requires situation at electric supply company, to take charge of engines, boilers, and their repairs, 9 years' experience with high-speed electric engines, good references.—"H. G. G.," 29, Victoria Road, Harborne, Birmingham. 1255

FOREMAN Wireman, experienced in the fitting of dynamos, accumulators, &c., seeks situation; good references.—1,303, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1303

POSITION Wanted, home or abroad, by experienced electrical and mechanical engineer, aged 34, previous Colonial and United States experience, last six years resident engineer in leading electricity works, excellent testimonials.—"X. Y.," 22, Buckingham Road, Brighton. 1295

WIREMAN (29), late R.N., seeks employment; could take charge small plant; references.—Address, FRY, Horsted Keynes, Sussex. 1291

ARTICLES FOR SALE AND WANTED, PARTNERSHIPS, &c.

Where Advertisements are to be answered to a given number, letter or *nom de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.

ACCUMULATOR RECHARGING.—Peto & Radford, Ltd., having increased their storage battery plant, are now prepared to make additional contracts for recharging accumulators of all sizes. Power available night and day. Telephone No. 6,994.—PETO & RADFORD, LTD., 57B, Hatton Garden, London, E.C. 2430

ACCUMULATOR Charging.—C. H. Cathcart & Co., having plant specially adapted for this purpose, charge cells of all sizes promptly, thoroughly, and cheaply. Terms on application. Accumulators on hire for temporary lighting, experimental uses, &c.—3, Dorset Buildings, Salisbury Square, Fleet Street, E.C. (Telephone No. 65,266). 7345

[*Continued on next page.*]

TO MANUFACTURERS OF DYNAMOS, MOTORS, TRANSFORMERS, &c.

ALTERNATOR, about 8 amps. 100 volts, wanted; also Motor, direct current 100—110 volts, about 1 H.P.—Price and full particulars to 1,294, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1294

CAPITAL WANTED for a Lucrative Electrical Fittings Business. Any gentleman with £2 000 at his command for investment, and with an amount of business experience (one with a knowledge of electricity preferred) will find an unexceptionable opportunity of employing the above. The business is increasing rapidly, and further capital and assistance is required at once. Only principals will be treated with—no agents.—Apply by letter in first instance, when personal interview will be arranged, to "ELECTRIC," Mather & Crowther, Ltd., 10—12, New Bridge Street, Ludgate Circus, E.C. 1295

FOR SALE.—Two 9 H.P. Gas Engines (Crossley Bros.), and the Electric Light Plant of the Junior Athenæum Club, 116, Piccadilly, W.—Applications to view, and further particulars can be obtained from the SECRETARY, at the above address. 1293

FOR SALE.—ELECTRICAL REVIEW, Vols. 33, 34, 35, bound half calf; also Vols. 36 to 40, unbound; all in excellent condition.—Offers to 1,297, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1297

FOR SALE.—The ELECTRICAL REVIEW, Vols. 9 to 17, bound; 18 to 20, unbound. The *Electrician*, Vols. 1 to 15, bound; 16 to 19, unbound. The *Electrical Engineer*, sundry early volumes. *Journal* of Society of Telegraph Engineers and Electricians, Vols. 1 to 15, unbound. *Minutes Proceedings* Civil Engineers, Vols 35 to 126, bound. *Transactions* Society of Engineers, 1878 to 1885, bound. *The Sanitary Record*, Vols. 1 to 10 ending June, 1879.—Apply Mrs. HILTON, 262c, King Street West, Ravenscourt Park, London, W. 1300

FOR SALE.—One set of 55 E.P.S. cells, 7 K type, in glass boxes with trays, insulators, and all accessories, capacity 25 amperes at 100 volts for 3½ hours. Recently erected, equal to new. May be seen by appointment. — ELLIS & WARD, 115, Edmund Street, Birmingham. 1208

MOTOR, direct, 50 volt, about ¾ H.P. wanted, E.C.C. preferred. —State price and particulars, 1,257, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1257

NEWLY-BUILT Premises to Let in Bury Street, Fulham Road, Chelsea, very suitable as charging station for motor-car cells, or for small workshop. Electric supply laid on.—For further particulars, apply CHELSEA ELECTRICITY SUPPLY CO., 19, Cadogan Gardens, S.W. 1252

PLATINUM in any form and quantity, purchased at highest prices by DERBY & Co., 44, Clerkenwell Road, London. 6523

SOUTH AFRICAN AGENCIES.—A well-established Johannesburg firm of mining engineers will consider offers of sole agencies for high-class electrical machinery and specialities.—1,246, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1246

WANTED.—Old scrap cable, wire, &c.; any quantity bought. —EDEY & Co, 29, Ludgate Hill. 1256

WANTED, Electric Lamp Tops and Scrap Platinum.—EDEY AND Co., 256, Ferndale Road, Brixton. a1006

CLOTH, POST FREE, 4s. 6d.

DYNAMO & MOTOR BUILDING

FOR AMATEURS,

With Working Drawings, by C. D. PARKHURST, Lieut. 4th Artillery, U.S.A., Assoc.Mem.Am.Inst.E.E.

Chapter I.—A Sma Electric Motor for Amateurs. Chapter II.—A "Home-Made" Electric Motor. Chapter III.—A Sewing-Machine Motor for Amateurs. Chapter IV.—Armature Windings, Connections and Currents. Chapter V.—A Fifty-Light Incandescent Dynamo. Appendix.

LONDON: H. ALABASTER, GATEHOUSE & CO.,
22, Paternoster Row, E.C.

THE

ELECTRIC RAILWAY OF TO-DAY.

By H. B. PRINDLE.

Fully Illustrated. Post Free 2s. 6d.

CONTENTS:—The Electric Railway; The Power Station: The Electrical Apparatus; The Switchboard; Line Construction; The Motor; The Motor Truck; Overhead Construction; Curve Construction; Storage Batteries.

TO BE OBTAINED FROM

H. ALABASTER, GATEHOUSE & CO.,
22, PATERNOSTER ROW, E.C.

FOR SALE BY PRIVATE TREATY.

ELECTRIC LIGHT PLANT, &c.

ARC LAMPS AND PARTS.

3 Brockie-Pell Arc Lamps, complete with outside Lanterns.
19 Brockie-Pell Arc Lamps, complete with round Globes wired.
2 Brockie-Pell, Globes only.
9 Copper Tops only for Globes Brockie-Pell Lamps.
2 Copper Tops, another pattern.
3 odd parts of another pattern.
3 Galvanised Iron Tubular Covers for Arc Lamps, Brockie-Pell.
13 Crompton Arc Lamps, one out of order.
12 Crompton Arc Lamps, somewhat damaged, all minus globes.
9 16¼" Crompton Globes, perfect.
1 16¼" Crompton Globe, cracked.
4 Globe Carriers and two spare ends.
2 Continuous Current Arc Lamps, out of order and without Globes.
10 Painted Iron Arc Lamp Reflectors, 3" in diameter (two in transformer room.)
12 5" Enamelled Reflectors for Arc Lamps.
12 Parts Johnson & Phillips Arc Lamps (Carbon Holders, &c.)
45 Bundles of Cored Carbons, 12", 15 m.m., 25 each bundle, 1,125'.
6 Bundles of Cored Carbons, 9", 10 m.m, 112'.
2 Coils of Steel cable for suspending Arc Lamps.
2 Choking Coils Crompton Solinoid, 9" × 3¾".
2 Choking Coils Crompton Solinoid, 6" × 3¾".

ALTERNATING CURRENT PLANT.

1 Crompton Alternator, A 2 type, 2,000 volts, 12½ amperes, 716 revs. per minute, excitation at full load, 100 volts, 8·25 amperes, complete with belt-driven independent exciter, foundation rails and pullies for driving.
1 Johnson & Phillips 1½ kilowatt Transformer, No. 1,732, 2,000 volts to 100 in cast-iron watertight case.
1 Main Switchboard for Alternator mounted with Nalder Ammeter 0 to 15 reading in virtual amperes.
1 Holt's Patent Voltmeter.
2 High Tension Main Fuses.
2 D.P. Main Switches.
2 D.P. Byng Switches.
D.P. Fuse in centre.
All mounted on suitable main board with uprights.

PLATING DYNAMOS.

1 Plating Dynamo, by Canning, 10 volts, 100 amperes, 900 revs.
1 Plating Dynamo, 4 volts, 30 amps., 1,300 revs.
1 Plating Dynamo, 4 volts, 20 amps., 1,000 revs.
1 Dynamo by Stafford & Eaws, Coventry, probable output 10 volts and 100 amperes.
1 Plating Ammeter, Kenning & Co., 300 amperes.
1 Plating Voltmeter, Kenning & Co., 12 volts.

SUNDRY ELECTRIC LIGHTING APPARATUS.

3 Old D.P. Main Switches.
10 Old Porcelain Base Switches, odd.
6 Odd Tumbler Brass Covers.
24 Porcelain Ceiling Roses.
36 Incandescent Lamps, various.
1½ lbs. Fuse Wire.
11 No. 1 Holders, new.
3 No. 2 Holders, new.
24 Old Holders, various.
1 Switch in watertight iron case.
2 Solenoids.
3 new D.P. Base and Cover Fuse Boxes, 5 × 2.
5 Hand Lamp Guards.
1 12" Resistance.
8 Resistances 12 × 3, German silver.
19 Circular Contact Switch on Board, 29 × 16.
1 Switch and Fuse Box, Bell Push on Teak Board, 14 × 10.

FILTERS, TANKS, OIL, &c.

1 Oil Tank minus Pump to hold 20 gallons.
1 No. 3 Well's Patent Filter.
30 Gallons of Oil in Cask, with Brass Tap.

SLIDES.

13 10" Opal.
4 6" Painted Fan.
5 10" Opal Glass.
3 7" Opal Glass.

TELEPHONE SUPPLIES AND INSULATORS.

2 Domestic Telephones.
2 old German Telephones.
1 Damaged Watch Receiver.
5 Copper Earth Plates, 24 × 24 × 3/16.
37 Brown Insulators, oil with bolts.
18 Medium Size Porcelain Shackles (no iron).
7 Small size Porcelain Shackles (no iron).
4 Porcelain Type Insulators, 7 × 1½.
35 Bobbin Type Insulators, 1" × 1½" deep.
2 Coils of Uninsulated Stranded Copper Wire.
About 10 lbs. No. 18 Bronze Wire.
6 Nickel Brackets.
1 Double Shackle complete.
10 12" Iron Eye Spikes.
3 smaller Iron Eye Spikes.
8 Large Terminals for Plating.
Miscellaneous Sundries.

ELECTRIC BELL MATERIAL.

4 5" Mining Bells.
1 6" Bracket Bell.
1 2½" Bracket Bell, very old.
1 Bell Relay and Case.
18 No. 2 Exhausted Dry Cells.
18 No. 2 Exhausted Le Clanché.
4 3" Wood Pushes.
1 2½" Wood Pushes.
1 Pear Push.
2 2" Wall Rosettes.
190 yards Bell Wire, mostly No. 20, I.R.D.C.C.
½ lb. Staples.
Cable in use, probably half a ton, (to be sold by weight).
We have included Transformer in Transformer Room. This, we expect, would be 2½ kilowatts.

The above may be viewed within the next day or two at the works of the CYCLE COMPONENTS TUBE CO., Bournbrook, Birmingham. 1296

ELECTRIC BELLS, TELEPHONES AND ACCESSORIES,

BATTERIES, PUSHES, &c.

SMALL MODEL DYNAMOS,

10 volts, 6 amperes, 3,000 revolutions per minute, adjustable brush rocker, splendid finish, **Price, 30s. each.**

For Prices of all kinds of Electrical Accessories,
APPLY TO

S. HARRISON, Manufacturing Electrician,
Office—697, ORMSKIRK ROAD, PEMBERTON, WIGAN.
Works—ELLESMERE MILL, NEWTOWN, WIGAN.
Registered Telegraphic Address:—"HARRISON, PEMBERTON." 1107

Cloth, Post Free, 2s. Illustrated with Working Drawings.

HOW TO BUILD A FIFTY-LIGHT DYNAMO

OR FOUR HORSE-POWER MOTOR.

By A. E. WATSON.

TO BE OBTAINED FROM

H ALABASTER, GATEHOUSE & CO.,
22, Paternoster Row, London.

Educational Notices.

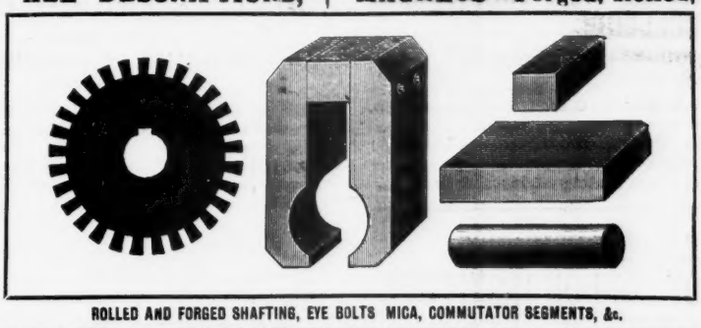
Official Notices.

TO MANUFACTURERS OF DYNAMOS, MOTORS, TRANSFORMERS, &c.

STAMPINGS OF ALL DESCRIPTIONS, | **MAGNETS—Forged, Rolled, Cast or Stamped, Finished, or in the Rough.**

DISCS up to 60 inches diam.
SLOTTED WORK a specialty.

Accuracy of Stamping and Highest Electrical Results Guaranteed.



SLABS & BARS in Suitable Sections for Magnets, Cold Sawn to lengths.

ROLLED AND FORGED SHAFTING, EYE BOLTS MICA, COMMUTATOR SEGMENTS, &c. 1243

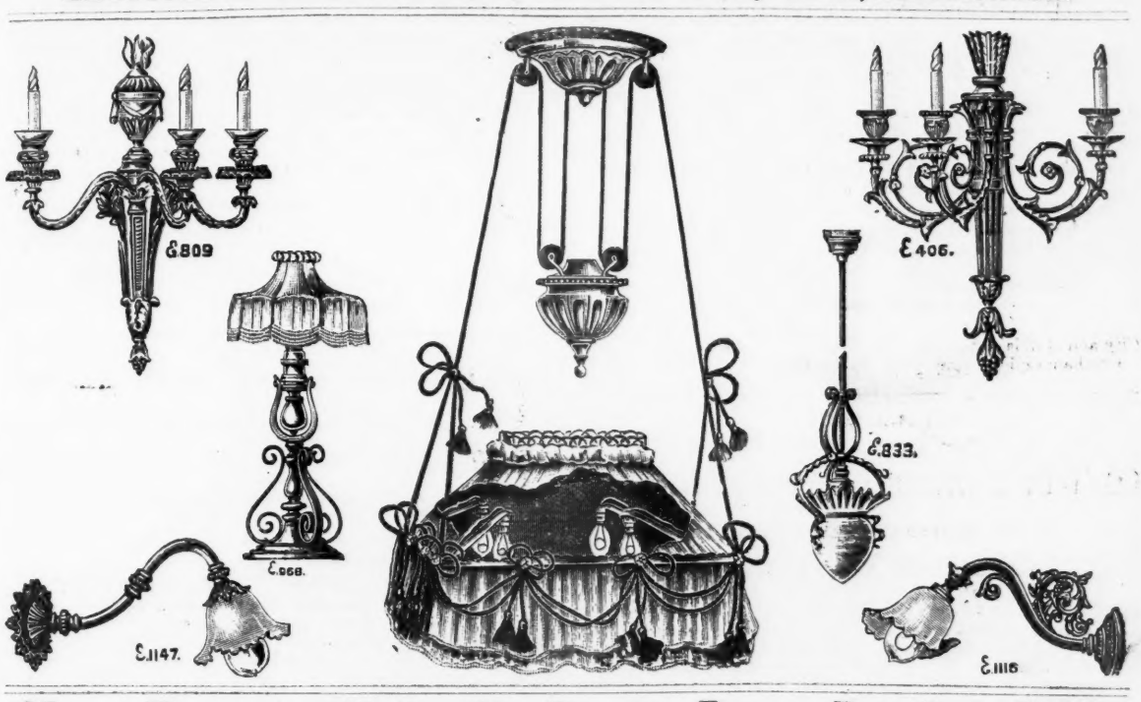
ROBERT JENKINS, 88, BISHOPSGATE ST. WITHIN, LONDON, E.C.
Telegraphic Address :—"Perr cable, London."

EVERED & CO., LD.

DRURY LANE, LONDON, W.C.
SURREY WORKS, SMETHWICK.
BARNET WORKS, BIRMINGHAM.

REGISTERED TRADE MARK R E & S E&Co

ELECTRICAL FITTINGS MANUFACTORY—Surrey Works, SMETHWICK.



Show-Rooms: 27 to 35, Drury Lane, London, W.C.

CATALOGUES OF FITTINGS AND ACCESSORIES SUPPLIED TO THE TRADE. 9672

STANDARD WORKS ON ELECTRICAL ENGINEERING,

By Professor SILVANUS P. THOMPSON, D.Sc. B.A., F.R.S., M.I.E.E.

DYNAMO-ELECTRIC MACHINERY.—A Manual for Students of Electro-Technic. Fifth Edition, with 520 Illustrations and 19 Folding Plates, 835 pp. 8vo, cloth. **24s.**

The ELECTRO-MAGNET & ELECTRO-MAGNETIC MECHANISM.—Second Edition, with 213 Illustrations. 8vo, cloth. **15s.**

POLYPHASE ELECTRIC CURRENTS AND ALTERNATING CURRENT MOTORS.—With 171 Illustrations. 8vo, cloth. **12s. 6d.**

London: E. & F. N. SPON, Ltd., 125, Strand. New York: 12, Cortlandt Street. 9675

Official Notices. | Official Notices.

Educational Notices.

THE ELECTRICAL & GENERAL ENGINEERING COLLEGE,

PENYWERN HOUSE, EARL'S COURT.

Principal: G. W. de TUNZELMANN, B.Sc. M.I.E.E. | *Senior Instructor* C. CAPITO, M.I.E.E., M.I.M.E.

Extensive Laboratories, Testing Rooms, Dynamo Room, Steam Engine, Workshops.

Recommended by most of the leading engineering firms. ***

ENGINEERING AND CHEMISTRY.

CITY & GUILDS OF LONDON INSTITUTE.

SESSION 1897-98.

THE Courses of Instruction at the Institute's Central Technical College (Exhibition Road) are for Students not under 16 years of age; those at the Institute's Technical College, Finsbury, are of an Intermediate Grade for Students not under 14 years of age. The entrance Examinations to both Colleges are held in September, and the Sessions commence in October. Particulars of the Entrance Examinations, Scholarships, Fees and Courses of Study, may be obtained from the respective Colleges, or from the Head Office of the Institute, Gresham College, Basinghall Street, E.C.

CITY AND GUILDS CENTRAL TECHNICAL COLLEGE,
EXHIBITION ROAD, S.W.

A College for higher Technical Instruction for Students not under 16, preparing to become Civil, Mechanical or Electrical Engineers, Chemical and other Manufacturers, and Teachers. Fees for a full Diploma Course, £25 per annum. Professors:—*Civil and Mechanical Engineering*, W. C. UNWIN, F.R.S., M.I.C.E.; *Physics and Electrical Engineering*, W. E. AYRTON, F.R.S., Past Pres. Inst.E.E.; *Chemistry*, H. E. ARMSTRONG, Ph.D., LL.D., F.R.S.; *Mechanics and Mathematics*, O. HENRICI, Ph.D., LL.D., F.R.S.

CITY AND GUILDS TECHNICAL COLLEGE, FINSBURY,
LEONARD STREET, CITY ROAD, E.C.,

Provides Courses of Intermediate Instruction for Day Students not under 14 years of age, preparing to enter Engineering and Chemical Industries. Fees, £15 per annum. Professors:—*Physics and Electrical Engineering*, S. P. THOMPSON, D.Sc., F.R.S.; *Mechanical Engineering and Mathematics*, W. E. DALBY, M.A., B.Sc, M.I.M.E.; *Chemistry*, R. MELDOLA, F.R.S., F.I.C.

JOHN WATNEY,
Hon. Secretary.

City and Guilds of London Institute,
Gresham College, Basinghall Street, E.C. c1011

Official Notices.

COUNTY BOROUGH OF BIRKENHEAD.

BIRKENHEAD CORPORATION ELECTRICITY SUPPLY.

TO ENGINEERS AND ELECTRICIANS.

THE CORPORATION OF BIRKENHEAD are prepared to receive tenders for the supply and laying complete of cables, street boxes, &c., in certain streets in the borough.

Plans can be seen, and a copy of the general conditions and the specification with form of tender, can be obtained on payment of One Guinea, to be returned on the receipt by the Corporation of a *bona fide* tender at the Town Clerk's Office, Town Hall, Birkenhead, or at the office of Mr. James N. Shoolbred, C.E., 47, Victoria Street, London, S.W.

The Corporation do not bind themselves to accept the lowest or any tender.

Tenders, which must be on the prescribed form, sealed and endorsed "Tender for Electrical Cables," must reach me not later than 5 o'clock in the afternoon of FRIDAY, JULY 23rd, 1897.

By Order,
ALFRED GILL,
Town Clerk.

Town Hall, Birkenhead,
July 10th, 1897.

COUNTY BOROUGH OF HALIFAX.

ELECTRIC TRAMWAYS.

TENDERS are invited for the supply of Trolley Wire, Bonds, and Insulators. Specifications and forms of tender may be obtained on application to Mr. T. P. WILMSHURST, Borough Electrical Engineer, Foundry Street, Halifax, on payment of £1 1s., which will be returned on receipt of a *bona fide* tender.

Sealed tenders, endorsed "Electric Line Construction," must be sent to the undersigned before 10 o'clock a.m. on Monday, July 26th, 1897. The corporation do not bind themselves to accept the lowest or any tender.

By Order,
KEIGHLEY WALTON,
Town Clerk.
1306

Official Notices.

COUNTY BOROUGH OF NEWPORT.

EXTENSION OF ELECTRICITY WORKS.

THE ELECTRIC LIGHTING COMMITTEE of the County Borough of Newport (Mon.) are prepared to receive tenders for the supply and erection of the following plant for the extension of the Municipal Electricity Works (the whole bound up in one specification, price £2 2s., returnable on receipt of *bonâ fide* tender):—

Section A.—
Boiler House Plant—Lancashire Boilers and Fittings, Mechanical Stokers, Feed Pumps, Economiser, Electric Motor, &c.

Section B.—
Steam and Exhaust Pipes, Valves, &c.

Section C.—
Engine House Plant—Steam Alternators and Exciters, Accumulators, Oil Filter and Tanks.

Section D.—
Switch Gear and Instruments.

Section E.—
Arc Lamps and Accessories.

Section F.—
Coal Elevator.

Section G.—
Allowance for Day-load Plant.

Tenderers are at liberty to tender for either Section, but not for part of a Section.

The ground plans of plant, and specification, with terms and conditions of tender and contract, may be obtained at the Offices of Mr. ROBERT HAMMOND, the Consulting Engineer to the Corporation, Ormond House, Great Trinity Lane, London, E.C., on and after Friday, July 9th, on payment of £2 2s. for each copy, which sum will be refunded on the return of the specification filled up with a *bonâ fide* tender. Tenders (sealed and marked "Tender for Electric Lighting") must be addressed to me at the Town Hall, Newport (Mon.), and be delivered on or before Friday, July 30th.

The Committee do not bind themselves to accept the lowest or any tender.

ALBERT A. NEWMAN,
Town Clerk.

Town Hall, Newport (Mon.),
July 1st, 1897. 1292

COUNTY BOROUGH OF SUNDERLAND.

ELECTRIC LIGHTING.

To Electrical Manufacturers and Ironfounders.

THE CORPORATION OF SUNDERLAND are prepared to receive Tenders for:—

1. Combined Arc Lamp and Trolley Poles.
2. Arc Lamps and Accessories.

Specifications can be obtained from Mr. JOHN F. C. SNELL, A.M.I.C.E., Borough Electrical Engineer, Dunning Street, at his office, on payment of a deposit of £1 1s. on each of the two specifications, which will be returned on receipt of *bonâ fide* tenders.

The persons or firms whose tenders are accepted will be expected to pay the rate of wages to workmen engaged in carrying out the work which is payable by the particular trade affected by the contract in the district where the work is executed.

Sealed Tenders, addressed "To the Chairman of the Highways Committee," Town Hall, Sunderland, must be sent to my office, on or before WEDNESDAY, JULY 28th, 1897, and not later than 12 o'clock noon on that day. Tenders to be submitted separately, and endorsed "Tender for Lamp and Trolley Poles," and "Tender for Arc Lamps," respectively.

The Corporation do not bind themselves to accept the lowest or any tender.

By Order,
FRAS. M. BOWEY,
Town Clerk.

Town Hall, Sunderland,
July 13th, 1897. 1299

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY, LTD.

NOTICE IS HEREBY GIVEN that the Transfer Books and Register of Members will be closed from the 14th inst. to the 28th inst., both days inclusive, preparatory to the payment of an interim dividend upon the Preference Shares of the Company for the six months ended 30th June, 1897.

By Order of the Board,
H. B. RENWICK,
Secretary.

Moorgate Court,
Moorgate Place,
London, E.C., *July 12th*, 1897. 1280

Official Notices.

BOROUGH OF DERBY.

DERBY CORPORATION ELECTRIC LIGHTING.

THE CORPORATION are prepared to receive Tenders for the Supply and Laying of High Tension Cables, Junction Boxes, Cable and Hauling Winch Section "A," Transformer Boxes, Switches, Safety Fuses, &c., Section "B," in the Borough of Derby.

Specification and form of tender may be had on deposit of £1 1s. (which will be returned on receipt of a *bonâ fide* tender), from Mr. J. E. STEWART, Engineer, Electric Lighting Station, Derby, on and after Monday, July 19th, 1897.

Tenders endorsed "Electric Lighting Tender for Cables, &c.," to be sent to the undersigned, not later than 12 noon on Monday, July 26th, 1897.

The lowest or any tender will not necessarily be accepted.

H. F. GADSBY,
Town Clerk.

Town Hall, Derby,
July 14th, 1897.

1309

Official Notices.

GLASGOW CORPORATION TRAMWAYS.

ELECTRICAL ENGINEER Wanted, to act as Assistant to Tramways Engineer in equipping and working Springburn Route on the Overhead System. Salary £4 to £5 per week, according to experience. Only those having practical experience in traction need apply. Applications, with copies of testimonials to be sent on or before MONDAY, JULY 26th, to Mr. JOHN YOUNG, General Manager, 88, Renfield Street, Glasgow.

349

HOW TO MAKE AN ELECTRIC MOTOR.

By EDWARD TREVERT.

ILLUSTRATED WITH FULL WORKING DRAWINGS.

Post Free, 6d.

H. ALABASTER, GATEHOUSE & CO.,
22, PATERNOSTER ROW, LONDON, E.C.

ADOPTED AT EDINBURGH, SUNDERLAND, SHOREDITCH, LEYTON, BEDFORD, PRESTON, CHELMSFORD, BRADFORD, PORTSMOUTH, MANCHESTER, EASTBOURNE, STAFFORD, ST. PANCRAS, WAKEFIELD, KILLARNEY, &c., &c
And by the London Supply Companies.
VARIOUS TYPES AND SIZES KEPT IN STOCK.
TYPE A
TYPE C
THE PATENT
DOULTON CONDUITS
FOR UNDERGROUND ELECTRIC MAINS
DOULTON & CO., Lambeth, LONDON, S.E.
WORKS: LAMBETH, LONDON, S.E.
ROWLEY REGIS, STAFFS.
SMETHWICK, nr. BIRMINGHAM.
ST. HELEN'S, LANCS.
BURSLEM. PAISLEY, N.B. PARIS.
DEPOTS: BIRMINGHAM, Granville St.
LIVERPOOL. Soho St.
MANCHESTER, Deansgate.
GLASGOW, Bothwell St.
PARIS, Rue de Paradis.
TYPE A
TYPE B2

NALDER BROTHERS & THOMPSON,

SUCCESSORS IN THE
AMMETER, VOLTMETER, AND SWITCH BUSINESS
TO
NALDER BROS. & CO.,

16, RED LION STREET, CLERKENWELL, EC.

SOLE MAKERS OF THE

N.C.S. AMMETERS & VOLTMETERS.

HIGH INSULATION,
6-INCH METAL DIAL,
BRASS COVER, BRASS BASE,
TERMINALS AT BACK.

JEWELLED BEARINGS,
ACCURATE, RELIABLE, HANDSOME.
MADE IN ENGLAND.

1896 Type, 6-inch Dial.

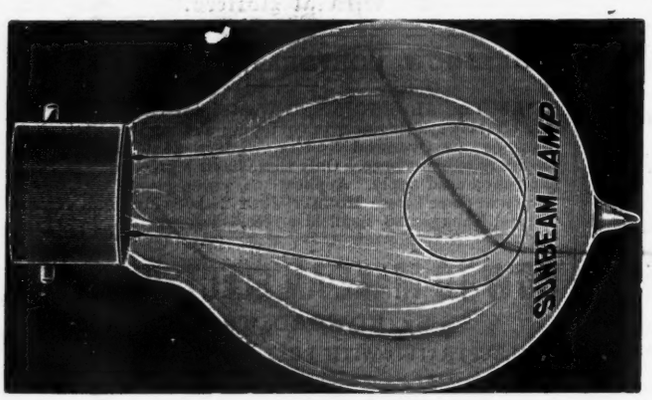
£1 17 6 UP TO **100** AMPS. **£2** UP TO **160** VOLTS.

SOLE ADDRESS:

34, QUEEN STREET, CHEAPSIDE, LONDON, E.C.

AGENTS:—Messrs. W. McGEOCH & Co., 108, Argyle Street, Glasgow; and Mr. S. JEVONS, Electric Stores, Minories, Birmingham.

a182



THE

"SUNBEAM"

LAMP CO., LTD.

GATESHEAD-ON-TYNE.

LONG LIFE! HIGH EFFICIENCY!

All Lamps Guaranteed

ENGLISH MADE.

ALL TERMINALS. ALL VOLTAGES UP TO 230.

LONDON OFFICE: 50, FENCHURCH ST., E.C.

MERSEY DYNAMOS AND MOTORS.

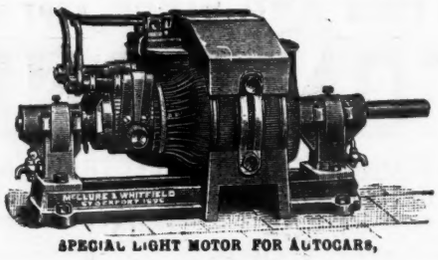
DYNAMOS

For
Arc and Incandescent Lighting,
Transmission of Power,
Electroplating & Depositing,
Electrolysis.

COMBINED PLANTS FOR SHIP LIGHTING, &c.

AT ANY VOLTAGE

FROM ⅓-H.P. UPWARDS.



SPECIAL LIGHT MOTOR FOR AUTOCARS,
Weight 170 lbs. B.H.P. 2.

MOTORS

For
Driving Cranes, Hoists
Pumps Tools,
and
All Classes of Machinery.

Prices and Full Particulars on application.

McCLURE & WHITFIELD, STOCKPORT.

Telegrams "McCLURE, Junr., STOCKPORT." a806

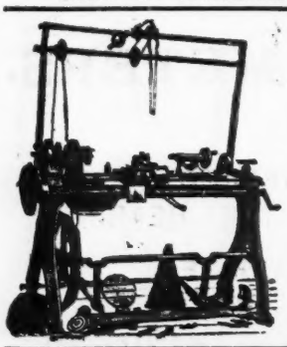
ELECTRIC WIRE & CABLE MACHINERY

Of the most modern design, for covering with Silk, Cotton, Hemp, Jute, Rubber, &c., Taping, &c.

Machines for Braiding, Varnishing, Waxing, Measuring, Stranding, Core Serving, Compounding, Cable Serving, Cable Sheathing.

The largest stock of patterns in the Trade.
Special machines designed and constructed.
Machines kept in Stock ready for Immediate Delivery.

THOMAS BARRACLOUGH,
Engineer and Machine Maker.
Offices—20 BUCKLERSBURY LONDON, E.C. 7947



HENRY MILNES,

Manufacturer of
HIGH-CLASS LATHES
FOR
ELECTRICAL ENGINEERS.
Ingleby Works,
BROWN ROYD, BRADFORD
Lathe Maker to the British and Foreign Governments.
ESTABLISHED 1858. 666

ELECTRIC WIRE CASINGS,
BLOCKS, CLEATS, BOARDS for SWITCHES
IN STOCK & MADE TO ANY DESIGN.
ACCUMULATOR CASES,
BATTERY BOXES, &c.
MADE TO ORDER ON SHORTEST NOTICE.

J. F. & G. HARRIS,

TIMBER MERCHANTS & MOULDING MANUFACTURERS.

YARDS and MILLS { 38, WILSON STREET, FINSBURY, E.C. / 42, ORANGE ST., Gravel Lane SOUTHWARK, S.E. / PALMER RD., Green St., BETHNAL GREEN, N.E. } LONDON.

THE PHŒNIX DYNAMO MANUFACTURING CO., Makers of all kinds of Electrical Plant, Hubert Street Works, Leeds Road, Bradford
See our Page Advertisement First Friday in each month.

THE

EMISSARY PATENT ELECTRICAL LUBRICANT.

REGISTERED TRADE MARK:

EMISSARY

Absolutely prevents all Sparking, Heating, and Friction on Dynamos, Motors, &c. The BEST and CHEAPEST Lubricant.
Commutators and Brushes run for years without any measurable wear.
Sample tins, 1s. 6d., post free a571
THE KINGFISHER PATENT LUBRICATION CO., LEEDS.

Now Ready, No. 10 of

THE AUTOMOTOR AND HORSELESS VEHICLE JOURNAL.

MONTHLY, ILLUSTRATED. PRICE 6D., POST FREE, 7D.; YEARLY, 7s.

No. 10 contains working drawings of Change and Differential Gear, Motor Trailer, &c., &c., Interview with Leading Motor Car Manufacturer, the new Hydraulic Life Boat "Queen," a Motor Car Exchange, Liquid Fuel Burners, the Month's Motor News, Inventions, Law Reports, &c., &c.

At W. H. Smith & Sons' Bookstalls, usual Newsagents, or direct from 1807
F. KING & CO., Ltd., 62, St. Martin's Lane, LONDON, W.C.

Fully Illustrated. Post Free, 4s. 6d.

THE ELECTRIC RAILWAY

By FRED H. WHIPPLE.

CONTENTS:-Chap. I., Historical Development of the Modern Method of Producing Electricity; Chap II., How Electricity is Mechanically Produced; Chap. III., Practical Thoughts upon the Lines of Force and the Production of Motion; Chap. IV., Something about Primary and Secondary Batteries; Chap. V., How Electricity is Applied to Street Railways; Chap. VI., The Application of the Motor to the Car; Chap. VII., Early Attempts at Electric Propulsion, with the Roads now in Operation; Chap. VIII., Some of the so-called "Systems" of Electric Street Railways; Chap. IX., Application of Electricity to Elevated and Underground Railways; Chap. X., Cost of Producing, Transmitting, and Applying Electricity for Street Railway Purposes; Chap. XI., Some further Comparisons of Electric Propulsion with other Methods; Chap. XII., The Electric Motor for Stationary Power Purposes; Chap. XIII., The Importance of Economical Steam Power to the Electric Current; Chap. XIV., The Utilisation of Water Powers for Electric Transmission; Chap. XV., The Purchase and Care of Good Belts; Chap. XVI., Conclusion—Some of the Possibilities of Electric Street Car Propulsion.

TO BE OBTAINED FROM

H. ALABASTER, GATEHOUSE & CO.,
22, PATERNOSTER ROW, LONDON, E.C.

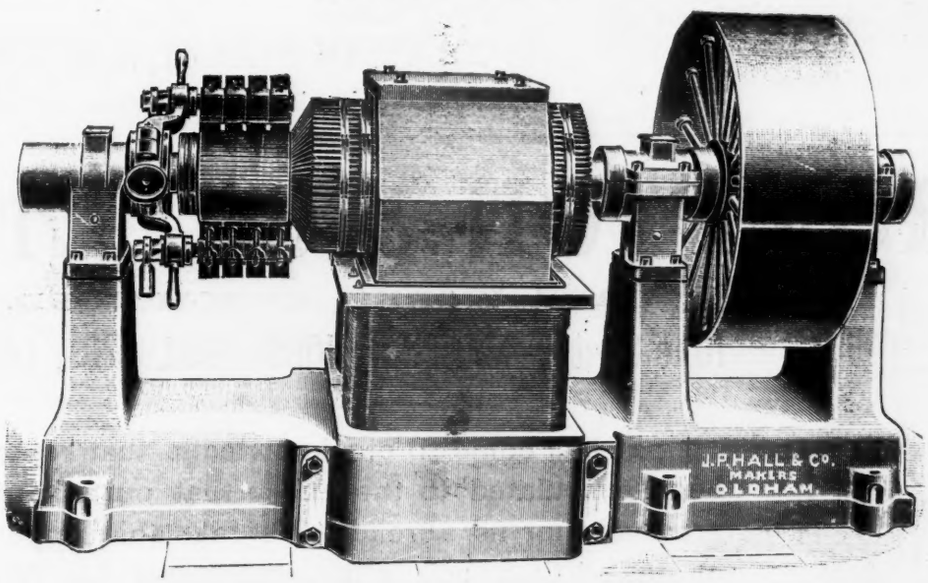
Stores, Minories, Birmingham. a180

J. P. HALL & CO., OLDHAM,

MAKERS OF

DYNAMOS & MOTORS

TELEGRAMS: DYNAMO } OLDHAM.
TELEPHONE No. 300 }



80 B.H.P. MOTOR.—450 REVOLUTIONS.

Swedish Charcoal Iron Sheets and Stampings.

TURNER BROS.,

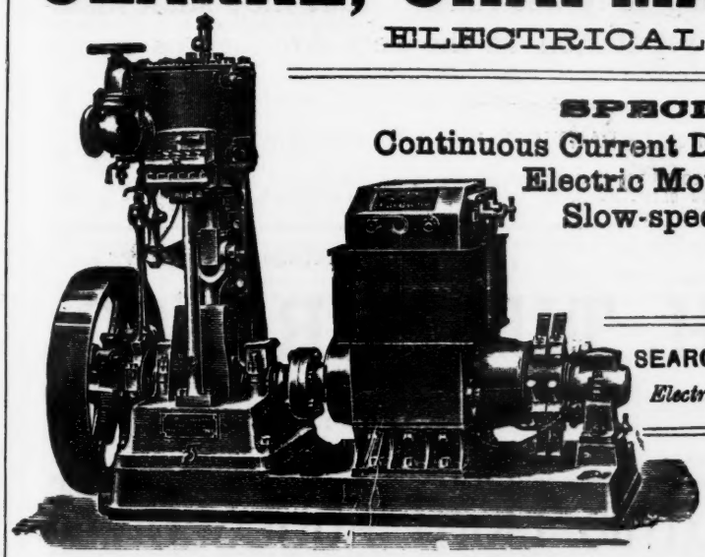
134, UPPER THAMES ST., LONDON.

Telegraphic Address: "CHESTIRON, LONDON." a115

FORGINGS FROM THE HAMMER, & MACHINED TO ANY DIMENSIONS.

CLARKE, CHAPMAN & CO., Ltd.,

ELECTRICAL ENGINEERS.



SPECIALITIES.

Continuous Current Dynamos, Alternators,
Electric Motors,
Slow-speed Direct-coupled
Engines and Dynamos
For Ship Lighting, &c.

SEARCH LIGHT PROJECTORS, ARC LAMPS

Electric Lighting and Power Transmission.

CONTRACTORS TO ADMIRALTY

GATESHEAD-ON-TYNE.

[ENGINEERING TELEGRAPH CODE USED.] a207

Established 1877. Telegraphic Address: "Unsworth, Derby.

G. B. UNSWORTH.

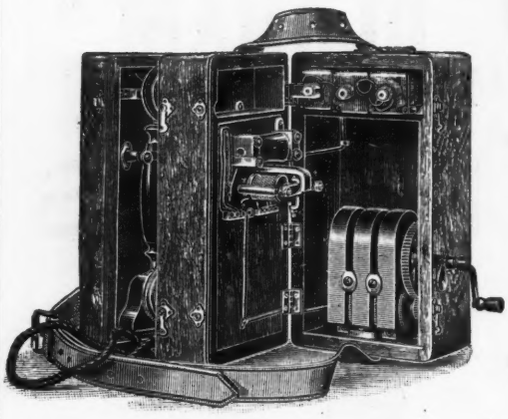
GREEN LANE MILLS
DERBY.

Manufacturer of Electrical Wires of every description for Electrical Instruments, Dynamo Machines, Telephones, and Electric Bells.

INSULATED LINE WIRES AND CABLES.

London Agents:—JOHN DAVIS & SON, 118, Newgate Street, E.C. a221

THE "PHŒNIX" DYNAMO MANUFACTURING CO., See our Page Advertisement First Friday in each month.



WESTERN ELECTRIC CO.,

MANUFACTURERS OF

TELEPHONE

and

EXCHANGE APPARATUS.

79, COLEMAN STREET, LONDON, E.C.

CHICAGO, NEW YORK, ANTWERP, PARIS, & BERLIN. 1906

CROMPTON & CO., LTD.,

ARC WORKS, CHELMSFORD.

HEAD OFFICE:—MANSION HOUSE BUILDINGS, LONDON.

Crompton-Pochin Lamp,

£4 15s.

Liberal Discounts to the Trade.

It has come to our knowledge that reports are being circulated to the effect that our Arc Lamps are made for us abroad. We take this opportunity of stating that such is not, and never has been, the case, and that **THEY ARE MADE ONLY AT CHELMSFORD, ENGLAND.**

Our latest pattern Arc Lamp has proved a very great success during the past season, and the sales have been quite beyond our expectations. Encouraged by this we are now introducing still further improvements, both in design and manufacture of these lamps, being fully determined that they shall maintain their reputation as the best Arc Lamps on the market.

FULL PARTICULARS ON APPLICATION.

POCKET PRICE LIST AND USEFUL FORMULÆ (Including Magnifying Glass), Post Free, 13 Stamps.
CROMPTON'S (Trotter's Patent) WIRING SLIDE RULE, 2s., Cloth, Case, 2s. 6d., Leather Case, 3s. 886

London Office:—
2, HOLBORN PLACE,
HIGH HOLBORN.

Telegrams:—"SWITCHES, BIRMINGHAM."

J. H. TUCKER & CO.,

MANUFACTURERS OF

ELECTRIC LIGHT ACCESSORIES

TUMBLER SWITCH, WITH FUSE.

16, OOZELLS ST., BIRMINGHAM. 6877

London Agents:—JOHN DAVIS & SON, 118, Newgate Street, E.C.

Shoreditch.—It is stated that within ten days of the opening of the electric lighting and refuse destructor installation, applications had been booked for the equivalent of 7,870 8 C.P. lamps. One application was for 200 H.P. for electric motors.

Tramore (Ireland).—The Grand Hotel has been lighted throughout electrically, an "Empress" dynamo supplying the current. Messrs. Tuck & Co., Limited, carried out the work.

Twickenham.—The Electrical and General Engineering Company has notified the Council that it intends to apply for a provisional order to supply electric light in the town. The Council will oppose the granting of the order.

Walsall.—The Town Council on Monday resolved to oppose the application of the Midland Electric Corporation for a Provisional Order. The Council is at the present moment applying for sanction to borrow £1,851 for electric lighting purposes.

Weston-super-Mare.—Mr. Hawtayne, of London, has been appointed consulting electrical engineer to the District Council to report on the subject of electric lighting and refuse destruction.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Birkenhead.—The Council last week discussed the tramway question, and resolved: "That a special committee be appointed to consider and report (1) As to the desirability of reconstructing and extending the system of tramways in the borough, and to submit estimates for the same; (2) as to the best system of mechanical haulage to be adopted in the borough; and (3) as to working the same." Mr. Cook, in proposing the resolution, said the Council had committed rather a destructive action in rejecting Mr. Ross's scheme recently proposed, and as there was evidently a general consensus of opinion in favour of some form of electrical traction, he moved this resolution. He had been agreeably surprised to find so many prominent men in the borough in favour of a bold policy, and he felt confident that they need not be afraid of even a large expenditure, for they had the vast body of ratepayers behind them The Council appointed a committee as follows:—The Mayor, Aldermen Deakin, Singleton, Bloor, Shaw, and Rawcliffe; Messrs. Gamlin, Benedict Jones, J. M. Kelly, William Price, G. S. Oldam, E. W. Oates, G. C. Rees, D. J. Kenny, G. P. Snape, and Thomas Cook.

Bristol.—A special meeting of shareholders of the Bristol Tramways and Carriage Company, held on 7th inst., formally approved of the draft order now being promoted before the Light Railway Commissioners for the construction of a light railway from Summerhill Road, in the parish of St. George, to Hanham, in the parish of Kingswood, Gloucester.

Brompton and Piccadilly Circus Electric Railway.—At the end of last week this Bill was under the consideration of a Select Committee of the House of Lords. Mr. R. D. M. Littler, Q.C., on behalf of the promoters, explained that the Bill provided for the construction, on the Greathead system, of an underground electric railway nearly 2 miles in length, from Piccadilly Circus to South Kensington, at depths varying from 50 feet to 70 feet below the surface. The stations would be close together—every 500 yards or so—this being specially arranged in the hope that, taken together with the quick service of trains, it would have the effect of driving some of the omnibuses off the road. The stations would be at Piccadilly Circus, Down Street, Hyde Park Corner, Knightsbridge, and at Brompton Road, where the line would run down and connect by a subway with the District Railway at Kensington Station. The capital power sought was £600,000, with power to borrow a further £200,000, and the estimates worked out at £248,000 a mile, which compared favourably with the estimates of other similar companies. Each train would carry 150 passengers; there would be three minutes' service, and the whole journey would take only 10 minutes, instead of 24 to 30 minutes at present occupied by the buses. Evidence having been taken as to the congested state of the traffic on the line of route, the committee adjourned until the following day, when Mr. Mott, chairman of the City and South London Railway Company, and one of the promoters, in cross-examination denied that there had been any serious leakages of electricity on the South London line.—Mr. Balfour Browne: Have you never heard that Mr. Preece detected the electric current from your railway as far away as Norfolk?—I heard him say once that he could tell when the line was working and when it was not.—And that he told a Committee of Parliament that he had had a little thing going round in his window which was worked by electricity from the railway?—No.—Witness also had not heard that Mr. Preece worked by electricity which escaped from the railway a bell which rang as loudly as one of the division bells in the House of Parliament. Witness explained that when the line was first opened electrical disturbances did occur at Greenwich, which on investigation were found to be due to escapes of electricity through the brick tunnels at the stations. Connections were then put across the brick tunnels and the disturbance stopped. There were no brick tunnels on the present line. A quantity of evidence was adduced in opposition, Sir Douglas Fox asserting that the scheme was in many respects inadequate, and that the estimates were much too low. The Committee passed the Bill, which will shortly be reported to the House for third reading.

Dover.—Some of the residents in Biggin Street strongly object to granite setts being put down there for the electric tramway track. They think wood blocks should have been laid, as they would be less inconvenient. The petitioners, however, ignored the fact that the cost of wood blocks would amount to something like double that of granite, and the maintenance of the road would be about three times as expensive. These facts were put forward at the last meeting of the Council, and it was also stated on the authority of the surveyor that wood blocks were liable to expansion and contraction, and therefore the rails would be very difficult to keep in gauge if these were used. A second payment of £2,000 has been made to Mr. Briggs on account of his contract for the tramway permanent way.

Great Northern and City Railway.—This Bill, which has already passed the House of Commons, was on Wednesday sanctioned by a Committee of the House of Lords. Under the Bill the company gain an extension of time within which to construct their railway, whilst further powers are conferred on the company to raise £80,000 additional share and loan capital.

Liverpool Overhead Railway.—A slight subsidence of the soil slightly interfered with traffic last week.

Middlesbrough.—A special meeting of the Town Council was held last week to consider the recommendation of the Streets Committee that the Bill promoted in Parliament by the Imperial Tramways Company for the electric tramway scheme should be opposed on behalf of the Corporation. A lively discussion took place, and the voting on the motion to confirm the recommendation was equal. The ex-Mayor declared in favour of opposing the Bill.

Portsmouth.—On Tuesday, the Council decided in favour of giving notice to acquire the local tramways, which are now owned by the Provincial Tramways Company, as the periods for purchasing the various sections fall due, with a view to introducing electric traction. Last year the company obtained a Special Act for this purpose, and the Corporation's opposition was withdrawn on their agreeing to take their supply of current from the municipal works. Negotiation for purchase followed. The actual cost of the purchase by arbitration is now estimated at £100,000.

St. Helens.—The electric lighting question was raised at the last Council meeting by Alderman C. J. Bishop, who drew attention to the fact that the Gas and Lighting Committee had in hand a scheme for an extension of the electricity generating plant, and urged that it was advisable the works should not be hurried forward, as the question of electrical traction for the local tramways had been raised, and it was possible that the two things might be dealt with together. Alderman Cook, chairman of the Lighting Committee, said the question of electrical traction for the tramways had not escaped the notice of the committee, but it was not customary for electric lighting plant to be used for electrical traction purposes. Councillor Griffin asked if the electrical traction plant, &c., would have to be provided by the tramways company or by the Corporation. The Mayor said the Corporation would find the electricity, and the company would pay them for it. In reply to Sir David Gamble, Alderman Cook said it was generally considered that separate installations of electricity were advisable for ordinary electric lighting and for traction purposes. At present the committee had as many customers and prospective customers for the electric light as they could supply with their present plant.

Swansea.—The Tramways and Electric Lighting Committee propose to re-open negotiations with the tramway company in regard to the proposed purchase and the adoption of electric traction.

The Light Railway Commission.—The list of applications to this Commission for orders authorising light railways includes the following:—Bridlington, Beeford, and North Frodingham, East Riding, Yorkshire, 9½ miles, steam; Derby and Ashbourne, Derby, 12 miles, Goole and Marshland, West Riding, Yorkshire, 14 miles, electric; Lastingham and Sinnington, North Riding, 3½ miles, Lincolnshire and Northamptonshire, 9 miles, and North Holderness, East Riding, 12½ miles, steam; West Manchester, Lancashire, 5½ miles, steam or electric; Llandudno and Colwyn Bay, Carnarvon and Denbigh, 8½ miles, electric.

The Clontarf Tramway.—It is stated that the Dublin-Clontarf Electric Tramway will probably be opened for public traffic within a fortnight or three weeks. The power house is nearly completed, as are also the track and overhead work.

TELEGRAPH AND TELEPHONE NOTES.

African Trans-Continental Telegraphs.—Despatches from Salisbury to the daily press state that part of the north of Africa is in a disturbed state. No vestige of the Trans-Continental wire remains, the natives having converted it into bullets.

Long Distance Telephony in Italy.—Some experiments in long distance telephony are about to be carried out between Milan and Rome, a distance of about 375 miles. It is said that the apparatus to be employed is of a new kind, lately invented by Sig. I. Giuliani.

TUMBLER SWITCH, WITH FUSE.

16, OOZELLS ST., BIRMINGHAM.

Telegraphic Interruptions and Repairs:—

CABLES.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Hong Kong-Amoy	June 24th, 1897 ...	July 8th, 1897.
Foochow-Shanghai	June 24th, 1897 ...	July 8th, 1897.
Bonny-Cameroon	June 25th, 1897 ...	July 12th, 1897.
Zanzibar-Mombassa	July 13th, 1897 ...	...
LANDLINES.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Siberian lines—		
Tschita-Bangkok	July 9th, 1897 ...	July 10th, 1897.
Saigon-Bangkok	July 9th, 1897 ...	July 10th, 1897.

April 19th, 1897.—Chio-Syra route impracticable.

April 19th, 1897.—During war between Turkey and Greece, cable between Trieste and Corfu cannot be used for messages for Turkey; they must be sent *vid* Bosnia, Montenegro and Servia.

The Ottoman Government announces that messages in secret language may not be sent to the Greek Minister and Consul in Turkey. They are to be sent in plain language.

April 2nd, 1897.—The Greek Administration prohibits secret language for private telegrams for Greece.

April 25th, 1897.—The Hellenic Administration notifies delay on press messages emanating from Greek provinces by reason of the lines being blocked.

May 26th, 1897.—The Ottoman Administration notifies that, until further notice, private telegrams for Crete must be written only in plain Turkish or French language.

No Landing for the French Cable.—An American exchange states that President McKinley has refused the French Telegraph Cable Company permission to land its lines on Cape Cod or any other part of the New England coast on the ground that similar requests made before by other companies for like privileges have been refused by the Government. One of the last appearances of Mr. Blaine at the Capitol was to submit an argument before the Senate Commerce Committee against granting the right of a French cable line to land on any part of the Carolina coast.

Post Office Telephone Exchanges.—In the House of Commons last week, in reply to Mr. Provand, Mr. Hanbury said: The Post Office has not at any time purchased or paid royalty for the right to use a telephone patent. Such instruments as it required before the expiration of the patent in 1891 were all of the Gower-Bell pattern, and were obtained by purchase under agreement with the holders of the patent.

Tapping Telegraph Wires.—Some allegations of tapping telegraph wires were made in a case heard on Wednesday in the Liverpool County Court, in which the plaintiff sued the defendant, the secretary of a small local club, for £2 10s. in connection with a bet on a horse race. The claim was resisted on the ground that the race was over when the bet was made, and it was alleged the result was not received in the club in proper time, owing to the telegraph line connected with the Exchange Telegraph Company's tape machine having been tampered with. A lineman in the employ of the Exchange Telegraph Company, said that on two occasions, one being the day of the race in question, it was found that a fine copper wire had been attached to the telegraph wire serving the club, and the end of the copper wire had been led into a cistern of water, the result being interruption. The judge held that the action was in respect of a betting transaction, and the plaintiff could not recover.

The Telegraph Wire Export Trade.—Compared with a year ago, a very active state of affairs is just now prevailing in the export trade of this country in telegraph wire and apparatus connected therewith. In June, 1896, the value of the exports only amounted to £19,680, while last month they reached the satisfactory total of £88,340 as compared with £61,226 in the preceding month. It is, however, in the returns for the first half of the year which the improvement in this branch of trade is best reflected. During the six months ending with June, the total exports were valued at £470,726, or an average of £78,455. For the first half of 1896 the exports were only £343,263, giving a monthly average of £57,210, while the 1895 returns gave—six months' exports £226,260, monthly average £37,610.

CONTRACTS OPEN AND CLOSED.

OPEN.

Birkenhead.—July 20th. The Corporation wants tenders for the wiring and lighting by electricity of the Woodside Ferry.

Birkenhead.—July 23rd. The Corporation wants tenders for the supply and laying complete of cables, street boxes, &c. Consulting engineer, Mr. J. N. Shoolbred, 47, Victoria Street, S.W. See our "Official Notices."

Derby.—July 26th. The Corporation want tenders for the supply and laying of high tension cables, junction boxes, cable and hauling winch, transformer boxes, switches, safety fuses, &c. Electrical Engineer, Mr. J. E. Stewart. See our "Official Notices."

France.—The French Post and Telegraph Authorities in Paris are inviting tenders, until the 27th inst., for the supply of a switchboard for the Wagram telephone office in that city. They are also inviting tenders until August 3rd for the supply of a quantity of electro-magnetic apparatus. Tenders to be sent to the Sous-Secretariat d'Etat des Postes et de Telegraphes, Rue de Grenelle, 103, Paris.

Halifax.—July 26th.—The Corporation want tenders for the supply of trolley wire, bonds, and insulators for the new electric tramways. Electrical engineer, Mr. T. P. Wilmshurst. See our "Official Notices."

Hammersmith.—July 21st. The Vestry wants tenders for electricity supply stores. Tenders to be delivered personally by contractors at the Vestry meeting on July 21st.

Hull.—July 29th. The Electric Lighting Committee want tenders for the supply, erection and hiring of certain plant and machinery required in connection with the electric lighting installation during the winter of 1897-8. Borough Electrical Engineer, Mr. A. S. Barnard.

Newport.—July 30th. The Electric Lighting Committee invite tenders for the supply and erection of boilers, mechanical stokers, and other apparatus for the boiler house plant, steam alternators and exciters, accumulators, steam and exhaust pipes, switch gear, arc lamps, posts, &c., coal elevator and "allowance for day-load plant." Consulting Engineer, Mr. Robert Hammond.

Rathmines.—July 19th. The Rathmines and Rathgar Commissioners are inviting tenders for the supply of a turbine, dynamos, &c., for lighting the New Town Hall. Particulars from the Secretary, Town Hall, Rathmines, Co. Dublin, on payment of 10s.

Roumania.—August 20th. Tenders are being invited by the General Direction of the Roumanian Posts and Telegraphs in Bucharest for the supply of 55,000 porcelain (double-bell) insulators. Tenders to be directed to the Direction Générale des Postes et des Telegraphes, Bucharest.

Russia.—November 1st. The Municipal Authorities of Novorossisk, South Russia, are inviting tenders for the concession for the construction and working of an electric tramway and for the electric lighting of the town.

Sofia.—September 22nd. The Secretary of State for Foreign Affairs has received a despatch from the Acting British Consul-General at Sofia, stating that the municipality of that town invite tenders for—(1) The supply of electric current to light the streets as well as public and private buildings in the town and the supply of electric power; and (2) The construction and working of electric tramways in the town and suburbs. Tenders will be received at the offices of the municipality of Sofia. Such further particulars as have been received may be seen at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

Spain.—August 5th. Tenders are being invited by the General Direction of the Spanish Posts and Telegraphs for the supply of 14 tons of copper sulphate for the telegraph service. Tenders to the Direccion General de Correos y Telegrafos, Madrid.

St. Helens.—July 20th. The Corporation want tenders for the supply and erection of plant and machinery for electric lighting extensions, including boiler, pump, economiser, alternators, exciters, switchboard, underground work, transformer sub-stations, &c. Consulting engineer, Mr. Robert Hammond.

Sunderland.—July 28th. The Corporation want tenders for combined arc lamp and trolley poles, and arc lamps and accessories. Electrical engineer, Mr. J. F. C. Snell. See our "Official Notices" for further particulars.

CLOSED.

Exeter.—The City Council has adopted a report of the Electric Lighting Committee which recommended that the tender of Messrs. Francis Parkin & Son, to supply 33 arc lamp posts with lamp brackets, and incandescent brackets, ladder arms, &c., for £10 each, and lowering gear at 30s. each (the latter if required), be accepted; the first instalment of the posts to be delivered by the middle of August and the balance one month later. They also recommended that the city surveyor obtain prices for the supply of street arc lamps.

Morecambe.—The tender of Messrs. W. Lucy & Co., Limited, of Oxford, has been accepted for the erection of seventy five arc lamps at Morecambe, the posts to be fitted with switches, wires, automatic devices and all accessories at an approximate cost of £3,000.

ELECTRICITY METERS.

A GOOD chance was afforded the members of the Municipal Electrical Association by the papers of Messrs. Wilmshurst and Couzens at the recent convention to give one another the benefit of varied individual experience. The opportunity was not neglected, and meter makers must have listened with rather mixed feelings to the caustic remarks of some of the speakers. But we will confine ourselves more particularly to the papers, and endeavour in a few words to crystallise out the facts presented as such from the theories and individual opinions which necessarily go to make up a "paper," but which are of a mere ephemeral value.

Mr. Wilmshurst's paper may be read as an impeachment of existing meters, and an attempt to categorically reply to the question, "What is a correct meter?"—using the term "correct" as we imagine the draftsman of electric lighting provisional orders intended it to be taken.

Summarising the subject, it is evident that the desirable qualities may be classed as either electrical or commercial.

ELECTRICAL CONDITIONS.

1. *Accuracy.*
   - (*a*) Integration of true watt-hours at all loads.
   - (*b*) Starting at low loads, and immediately stopping when main current turned off.
   - (*c*) Not affected by outside influence, or capable of being readily tampered with.
   - (*d*) Reliable, because not susceptible to vibration, temperature, frequency, or barometric changes.

2. *Non-interference with Supply.*
   - (*a*) Small drop in series coil.

COMMERCIAL CONDITIONS.

1. *Maintenance.*
   - (*a*) Durable; upkeep and repairs very small.
   - (*b*) Labour and inspection small; no winding or periodic adjustments.
   - (*c*) Small or negligible shunt coil losses.
   - (*d*) Readily checked *in situ*, &c.

2 *Financial.*
   - (*a*) First cost small.
   - (*b*) Equally suitable for continuous and alternating currents.

From the foregoing, slightly altered in arrangement from the sequence given by the writer of the paper, it is evident Mr. Wilmshurst had ample scope; but we hardly agree with him in his pessimistic views. He allows higher limits of error than are really necessary nowadays (*e.g.*, 4 per cent. at one-tenth load), and condemns compensating devices as well as commutators, whereas the former, when properly designed according to known definite laws, are rarely troublesome in experienced hands, and the commutator of the Elihu Thomson meter has made its success, while the old mercury commutator of eight and nine years ago doomed the old Hookham meter to oblivion.

Vibration is one of the troubles that the meter tester must take into account, and meters should be vibrated (as they will be in practice) while being tested, otherwise they read high afterwards, and may run on the shunt. But inductance, as causing trouble by reversing the direction of rotation, is more often heard of than met with. And several exhaustive tests we have made have failed to show any result *unless a magnetic adjusting shunt happened to be placed across the series and shunt coil magnet poles.* Then a little consideration made it evident that the flux through this bye-pass actually reversed with high inductance and caused a reflex action, tending towards and finally causing a reversal in sense of rotation.

The actual shunt losses, or watts absorbed in shunt coils of energy meters, as given by Mr. Wilmshurst, are, we think, lower than the average, as tests of several hundred meters, and amongst them four or five makes, would not have led us to fix the values as all falling below 3½ watts!

The drop in series coils is, on the other hand, too frequently under-estimated. One well known meter can always be expected to cause a fall in pressure of from 2 to 2½ volts at full load. But in another, and practically an equally good instrument, the drop is always so small a fraction of a volt that it is difficult to accurately measure the exact amount.

The stopping device of a piece of iron on the rotating disc being attracted by an auxiliary brake magnet, is used on the Hümmel as well as the Hookham meter, but on the latter it is not essential, as reasonable security can be obtained by careful adjustment, even where the device is absent.

With reference to Mr. Wilmshurst's remarks on the testing of meters, it is well to note that *both* ends of the shunt coils must be on separate leads from the series coils if accuracy be desired, as otherwise the pressure across the coils varies so much between the first and last as to seriously prejudice the value of the tests.

The meter question, from the aspect of prepayment meters, was also brought before the Convention by Mr. Couzens, of Taunton, who was chiefly concerned with the desirability of using penny-in-the-slot devices in conjunction with the so-called "free" wiring.

It is hardly too much to say that, after all, a meter must be judged by its behaviour when installed on consumer's premises, and that as station managers are gradually realising that the shunt losses of meters do not represent full price units, or—to go the full length—that they represent anything that is really felt in the costs of any ordinary station; the most important points are:—

"Correctness."—1. An all-round accuracy of as near 2 per cent. correctness as possible.

"Satisfactory."—2. A certainty of starting at one-twentieth load and of stopping at no load.

"Supply."—3. Negligible pressure drop in series coils.

"Maintenance."—4. A minimum of attendance, repairs, and shunt-coil losses.

"Capital."—5. Bought at £5 or under, complete and delivered.

The M.E.A. papers are to be appreciated as having given rise to a brisk interchange of opinion, and as containing enough contentious matter to satisfy the most ardent debater, while one or two new facts are presented, with a good summary of "desiderata," together with Mr. Wilmshurst's opinions of how far they are met.

NOTES.

The Summer Meeting of the Institution of Mechanical Engineers.—The summer meeting of this Institution will be held in Birmingham, and will commence on Tuesday, July 27th. The presidential address will be delivered by Mr. E. Windsor Richards, and the following are among the promised papers:—"High Speed Self-Lubricating Steam Engines," by Mr. Alfred Morcom, of Birmingham. "Mechanical Features of Electric Traction," by Mr. Philip Dawson, of London. "Diagram Accounts for Engineering Work," by Mr. John Jameson, of Newcastle-on-Tyne. There will be excursions to various places of interest, and the following are among the works, &c., to be visited:—Messrs. Belliss and Co., Engine Works, Ledsam Street; Birmingham Electric Supply Station, 14, Dale End; Messrs. Elkington and Co., Electroplating and Gilding Works, Newhall Street; Municipal Technical School, Suffolk Street; National Telephone Company, Switchroom, 95, Colmore Row; Messrs. F. and C. Osler, Glass Works, 230, Broad Street, and Freeth Street; Messrs. Winfield, Art Metal Works, Cambridge Street; Electric Construction Works, Stafford Road, Wolverhampton; Messrs. Thomas Parker, Electrical Engineering Works, Wednesfield Road, Wolverhampton; Wolverhampton Corporation Electric Lighting and Power Station, Commercial Road, Wolverhampton; Messrs. Edwin Danks & Co., Boiler Works, Oldbury. The following are notes regarding Mr. Dawson's paper on "Mechanical Features of Electric Traction." "Importance of electric traction on tramways. Outside work: wires, poles, insulators. Rolling stock: car bodies, trucks, frames; four-wheel cantilever truck; swivel truck. Motors: single reduction; steel gearing; power; suspension; rating; rise of temperature. Power station, continuous working; sizes of engines, driving of dynamos; power and class of engines; governing; bearings. Coal consumption. Fly-wheels; construction and accidents. Generators."

Telegraphy without Wires.—A daily paper says that Signor Marconi left Spezzia on Wednesday, for London, to submit his invention for telegraphing without wires to a company. He states, however, that he will grant to the Italian Government the free right of making use of his invention. The Emperor William has requested the inventor to give a demonstration of the working of his apparatus in Berlin. Signor Marconi will, consequently, go to Germany on his way home from England.

We understand that the acceptance of the Marconi patent has been voluntarily held back on the payment of certain fees, for the reason that negotiations for the sale of the invention were pending, and if such negotiations were successful, foreign patents were to be applied for. It was held that to enable foreign patents to be taken out, it was necessary that the publication of the specification of the English patent should be delayed.

American Association for the Advancement of Science.—The programme for the Detroit meeting of the above Association, which will be held from August 9th to 14th, contains a list of papers to be presented from the University of Michigan, Johns Hopkins University, Massachusetts Institute of Technology, Cornell University, Princeton University, Lehigh University, and from many of the most important laboratories in the United States. We understand that many distinguished physicists and electricians have expressed their intention to attend this meeting, and to take part in the discussion of the many important and interesting papers to be presented. The British Association for the Advancement of Science meets August 18th, at Toronto, and a number of its members have already signified their intention of being present at Detroit, and taking part in the proceedings of the Physics Section. The programme is remarkably strong in electrical papers, particularly on alternating currents. We abstract the following:—

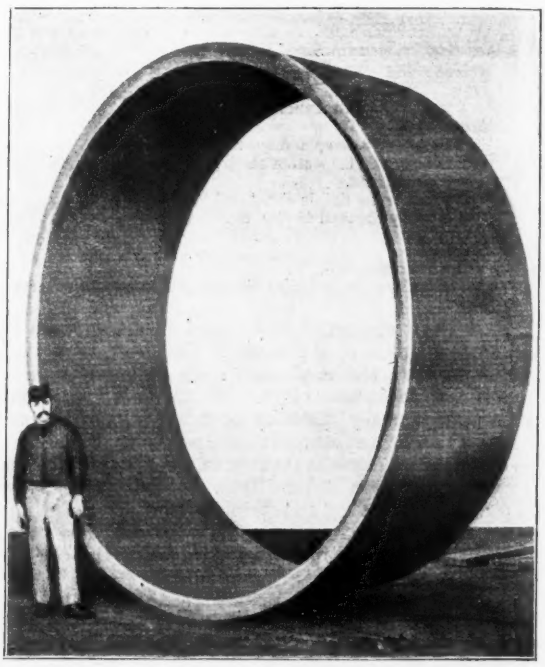
Section B.—Physics. Tuesday, August 10th. The following papers will be read:—

"Screening Effect of Induced Currents in Solid Magnetic Bodies in an Alternating Field," by Mr. Charles P. Steinmetz, General Electric Company, Schenectady, N.Y. "The Design, Construction and Test of a 1,250-watt Transformer," by Prof. Henry S. Carhart, Univ. of Mich., Ann Arbor, Mich. "Electrolytic Action in a Condenser," by Dr. K. E. Guthe, Instructor in Physics, Univ. of Mich., Ann Arbor, Mich. "On the Velocity of Light in a Magnetic Field," by Prof. E. W. Morley, Cleveland, Ohio; Prof. H. T. Eddy, Minneapolis, Minn.; and Prof. D. C. Miller, Cleveland, Ohio. "The Magnetic Survey of Maryland," by Dr. L. A. Bauer, Univ. of Cincinnatti, Cincinnati, Ohio. "The Transmission of Radiant Heat by Gases at Varying Pressures," by Mr. Charles F. Brush, Cleveland, Ohio. "The Effect of Heat on the Elastic Limit and Ultimate Strength of Copper Wire," by Prof. Frank P. Whitman, Adelbert College, Cleveland, Ohio, and Mary C. Noyes, Ph.D., Lake Erie Seminary, Painesville, Ohio. "Arc Spectra," by Prof. Arthur L. Foley, Univ. of Indiana, Indianapolis, Indiana. "On the Brightness of Pigmented Surfaces under Various Sources of Illumination," by Prof. Frank P. Whitman, Adelbert College, Cleveland, Ohio. "The Discharge of Electrified Bodies by X-rays," by Dr. C. D. Child, Cornell University, Ithaca, N.Y. "The Electric Conductivity of certain Specimens of sheet Glass, with reference to their Fitness for Use in Static Generators," by Prof. Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio. "Graphical Treatment of Alternating Currents in Branch Circuits in case of Variable Frequency," by Prof. H. T. Eddy, Minneapolis, Minn. "On Simple Non-Alternating Currents," by Prof. Alexander Macfarlane, Lehigh Univ., South Bethlehem, Pa. "Exhibition of Instruments for determining the Frequency of an Alternating Current," by Prof. George S. Moler, Ithaca, N.Y., and Dr. Frederick Bedell, Cornell Univ., Ithaca, N.Y. "The Predetermination of Transformer Regulation," by Dr. F. Bedell, Cornell Univ., Ithaca, N.Y., Prof. R. E. Chandler, Salem, Va., and Mr. R. H. Sherwood, Brooklyn, N.Y. "A New Form of Coal Calorimeter," by Charles L. Norton, Mass. Inst. of Technology, Boston, Mass.

The Cowper-Coles Gold Recovery Process.—The principal feature claimed for the Cowper-Coles process is an aluminium cathode, which is said to overcome one of the chief difficulties appertaining to the economical recovery of gold from weak cyanide solutions by electrolysis. In the Siemens-Halske process, lead foil or lead strips are used, the cutting up of which is a tedious matter. A clean up is made every seven to eight weeks when the wood frames carrying the lead strips are withdrawn, the lead strips removed and new substituted, the auriferous lead being ultimately melted down and conveyed to a central works to be cupelled. This method, it is asserted, is both crude and expensive, the labour of fitting the strips into the frames is considerable, and the consumption of lead is a large item, it having been computed by Mr. Von Gernet, at the Worcester Mine, at 1·10 of a penny per ton of ore treated. It is claimed that the Cowper-Coles process overcomes these difficulties, aluminium plates being substituted for the lead foil, and advantage being taken of the fact that a loose oxide is formed on the surface of the aluminium, which enables the deposited gold to be readily stripped or wiped from the cathodes as pure gold. Gold by this process has been successfully extracted from cyanide solutions containing only ·01 per cent. of cyanide of potassium, 2½ dwts. of gold to the ton of solution. The substitution of aluminium for lead foil or strip, enables the gold to be obtained as pure gold, and also daily returns to be made of the amount of gold recovered; it also has the additional advantage of reducing the cost of labour and economising the amount of cyanide of potassium used, as the solution is not contaminated by any base metals such as zinc, as in the MacArthur-Forrest process. At a future date we hope to be able to give further details of this process.

Paper Cable Litigation.—There will shortly be heard in the States an action brought against New York and New Jersey Telephone Company of Brooklyn, by the National Conduit and Cable Company of New York, for infringement of patents on the manufacture of paper-covered cables owned by the plaintiffs. The defendants deny infringement.

Large Nickel Steel Work.—We reproduce the following illustration from a paper by Mr. Porter, which was abstracted in a recent issue of American *Modern Machinery*. The figure shows a large nickel steel field ring, which was made for one of the Westinghouse electric power generators at the



Niagara Falls. It is forged without a weld, and the following dimensions will interest British manufacturers:—Outside diameter, 11 feet 7⅜ inches; width, 4 feet 2¾ inches; thickness, 4 11/16 inches; weight, 28,840 lbs.; tensile strength, 83,000 lbs.; elastic limit, 53,000 lbs.; elongation 27 per cent.

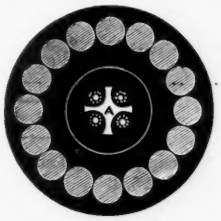
The Lighting of Palaces.—It is very probable, says the *St. James's Gazette*, that the practical result of the fire at Buckingham Palace last week will be the introduction of the electric light into the bed chambers and sitting rooms commonly occupied by distinguished guests and their suites. On the last occasion on which guests were in residence—the week of the wedding of the Princess Charles of Denmark—a similar outburst of fire took place, under very similar circumstances. Up to the present the Palace has lacked a general electrical installation, for the reason that it is so seldom occupied. The Queen herself offers no objection to the introduction of electricity into the Palace, apart from the great disturbance of the mural decorations that would take place. Mr. Massey is understood to have advised the work, even if it should not be extended to the state apartments; and her Majesty's officials are not blind to the fact that the Palace is far less well protected against fire than Windsor Castle, which could be placed under water in a few minutes by opening the sluices of Cranborne Tower.

Appointments.—The Shoreditch Vestry has made the following appointments for the vacant posts recently advertised:—Electrician-in-charge, Mr. George Kemp, A.I.E.E., of Wolverhampton; superintendent of mains, Mr. H. J. Roscoe, of Birmingham. Mr. C. N. Russell is the chief electrical engineer.

The St. Pancras Vestry has appointed Mr. J. Leadbeater, of Great Yarmouth, as an assistant electrical engineer at the lighting station.

Appointment Vacant.—A secretary is required by the Institution of Mechanical Engineers. Applicants must have had such technical training as shall fit them for editing engineering proceedings and carrying on the work of the Institution. Salary, £700 per annum. Applications and inquiries to be made to the President of the Institution of Mechanical Engineers, 19, Victoria Street, Westminster, S.W., by August 31st.

Smith & Granville's Telephone Cable.—A 3-mile length of 4-wire cable, constructed on a novel principle, has recently been laid across the Solent for the Post Office. The cable has been constructed by the Telegraph Construction and Maintenance Company, and contains a four-wire air space core, designed and patented by Mr. Willoughby Smith and Mr. A. Granville. The special feature of this core is



A, Air space.

the low capacity between wire and wire; this between the diagonal wires being about ·1 microfarad per knot only, and between contiguous wires a little more than this. The actual tests of the completed cable show the following results:—

Capacity per Knot.

Wires.				
1	...	...	·1929 mf.	Wire and earth with other wires earthed.
2	...	...	·1954 „	
3	...	...	·1947 „	
4	...	...	·1971 „	
1 and 3	...	...	·0998 „	Between diagonals.
2 and 4	...	...	·1002 „	
1 and 2	...	...	·1119 „	Between contiguous wires.
3 and 4	...	...	·1125 „	

It may be added that the resistance per knot of the conductors is 4·8 ohms approximately, and the insulation to earth of each wire about 1,000 megohms, that between wire and wire being considerably in excess of this.

Prolongation of Patent.—It is announced in the *London Gazette* that application is to be made by Illius Augustus Timmis, of 2, Great George Street, who is the proprietor of letters patent granted to Stanley Charles Cuthbert Currie, of 21, Clarges Street, Piccadilly, gentleman, and Illius Augustus Timmis, of 17, Great George Street, Westminster, civil engineer, for an invention of "Improvements in the means for working and interlocking railway signals by electricity," dated December 12th, A.D. 1883, No. 5,718, for a prolongation of the patent. The petition will be heard on August 17th by the Judicial Committee of H.M. Privy Council.

Personal.—Mr. Rankin Kennedy has been appointed consulting electrical engineer for Messrs. Chorley & Pickersgill's Electrical Printing Works, Leeds. In these new works every machine is to be driven by direct coupled electromotors. The generating plant will be about 200 horse-power.

The Institution of Junior Engineers.—On Saturday, July 3rd, a large party of the members availed themselves of Prof. Ewing's invitation to visit the Engineering Laboratory at Cambridge in connection with the University. Every preparation had evidently been made to render the occasion pleasant and interesting. All the apparatus was displayed in the various rooms; the engines, &c., were running, experiments were conducted on the testing machines, and on the elasticity and other instruments. After the reception by Prof. and Mrs. Ewing, the members were shown over the whole building. The laboratory was only opened in 1893, but the advantages offered are so greatly appreciated, that last term the number of students attending was no less than 107. The teaching is carried on by the professor and five demonstrators, with workshop instructors in carpentry, pattern making, fitting and forging. Lectures are given on the subjects of the Mechanical Sciences Tripos, viz.:—Mathematics, mechanics, strength of materials and theory of structures, principles of mechanism, heat and heat engines, applied electricity; along with practical work in mechanics and elasticity, heat, surveying, drawing, and electricity. In the teaching of these subjects a variety of machines and apparatus are employed, most of which have been made in the University workshops. Prof. Ewing, in showing them, invested his explanations with such interest, that at the conclusion of the inspection the visitors appeared quite reluctant to leave. For the kind reception which had been extended to them, their acknowledgments were expressed by the chairman of the Institution, Mr. H. Bloomfield Vorley. On leaving the laboratory special visits were made to Peterhouse, King's, and Trinity Colleges, and also to the electric light station, where the engineer, Mr. John H. Barker, showed the members round.

The members will visit the combined electric lighting and dust destruction undertaking of the Shoreditch Vestry tomorrow, July 17th.

The outline programme of the Irish Summer Meeting, which is to be held from August 14th to 21st. On Saturday, August 14th, a reception will be given at Trinity College, Dublin. On Monday the electricity works will be visited. On the Tuesday the electric tramway works will be visited, and the members will leave Dublin for Belfast. On Wednesday various Belfast works will be visited, including the electricity works. On Thursday there will be an excursion to Larne to visit the factory of the British Aluminium Company. The Institution dinner will be held at Belfast on Friday evening.

Cricket.—The St. Pancras Electricity Department have formed a cricket club, and would be glad to arrange matches with other electrical clubs.

The Electrical and General Engineering College, Earl's Court.—The following were the successful candidates at the June examinations for entrance scholarships and exhibitions tenable for two years:—Scholarship of £50 per annum, R. J. Collard, age 18, Canterbury; scholarship of £25 per annum, J. A. Wickham, aged 16; Reading Exhibitions of £15 per annum, C. Stubbs, age 16, Reading; and J. A. Hill, age 15, Parmiter's Foundation School.

Retirement.—The Scotch papers announce the retirement, after 40 years connection with the service, of Mr. Andrew Gray, the controller of Scotch telegraphs, Edinburgh.

Forthcoming Book.—Messrs. Archibald Constable & Co. propose to publish shortly a life of Sir Charles Tilston Bright, the distinguished engineer and pioneer of electric telegraphy, who was knighted when but 26 years of age for laying the first Atlantic cable. The work, compiled by a brother and son, is based largely on the diaries kept by Sir Charles Bright, and reads like an auto-biographical narrative of truly stirring events. It will be issued by subscription in two handsome volumes, and the number printed will be strictly limited.

NEW COMPANIES REGISTERED.

Galway Electric Company, Limited (2,027).—Registered in Dublin on December 21st, 1896, with capital £8,000 in £1 shares, to carry on the business of electrical and mechanical engineers in all its branches in such manner and place as the company may deem fit, and either alone or in connection with any other trade or business. The subscribers are:—John Perry, Royal College of Science, London, S.W., 50 shares; Professor of Mechanics and Mathematics, F.R.S., 50 shares; James Perry, Wellpark, Galway, civil engineer, County Surveyor, Galway, M.E., M.I.C.E., 50 shares; Alice M. Perry, 8, Gilston Road, London, married woman, 50 shares; Martha Perry, Wellpark, Galway, married woman, 50 shares; Agnes Perry, 35, Wellington Place, Belfast, widow, one share; Janet Park, Wellpark, Galway, spinster, one share; Eliza Jowett, Linden House, Crabtree, Sheffield, spinster, one share. The number of directors is not to be less than three nor more than seven; the first are John Perry, James Perry, Mrs. A. M. Perry, and Mrs. M. Perry; qualification 50 ordinary shares; remuneration to be fixed by the company. Registered office, Newtownards, Galway. Registered by Blake & Kenny, 4, Dame Street, Dublin.

Safety Concentric Wiring Company, Limited (53,172).—Registered July 2nd with capital £30,000, in £1 shares (2,000 deferred), to acquire and carry on the business of electrical and mechanical engineers, and manufacturers of electric light appa-

ratus carried on as the "Safety" Concentric Wiring Company, at 5 and 6, Bovay Street, Holloway, N., and to adopt a certain agreement. The subscribers (with one share each) are:—A. Watson, 104, St. Stephens Road, East Ham, accountant; E. J. Piper, 34, Victoria Street, S.W., engineer: J. B. Cumberland, 91, Cambridge Street, Eccleston Square, S.W., engineer; M. J. Scott, 54, Tufnell Park Road, N., electrical engineer; T. S. Shead, 8, Auckland Road, S.W., draughtsman; A. T. Ebsworth, 176, Dalston Lane, N.E., clerk; A. Thompson, 17, Broad Hinton Road, Clapham, clerk. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first. Qualification £100; remuneration as fixed by the company. Registered by Guscotte & Fowler, 1, York Buildings, Adelphi, W.C.

CITY NOTES.

Crompton & Co., Limited.

WE are pleased to note that the accounts of this company for the year ending March 31st once again show a net profit, the amount stated being something over £4,000.

With the issue of the report and accounts is put forth also a circular which gives the plans of the directors for re-arranging the capital account of the company. This circular we give in full in another column, and we need not therefore discuss it in detail here, but the writing down of "the various investments of the Company and Doubtful Debts, the Patents Accounts, and the Goodwill Account," to the extent of £78,396, will probably commend itself to most people. The way in which it is to be accomplished is, however, open to much criticism. The uncalled capital is to be called up, so that the holders of £5 ordinary shares, £1 paid, will have to pay up £4, and then submit to having their £5 shares written down to £3. By the way, it is not quite clear to us why this uncalled capital has not been called up previously, seeing that borrowing from the bankers has been resorted to for some time past. The whole capital, whether in ordinary or preference shares, it is intended to write down from £5 to £3 per share, and the preference shareholders are expected to submit to their shares being converted into ordinary shares, thus waiving their right to the cumulative dividend of 7 per cent. per annum for the past five years, and in addition are to give up their preferential position in any distribution of capital in case the company should wind or be wound up.

It is difficult to see how the directors arrive at the conclusion that the "arrangement proposed appears to be a fair and just one." The preference shareholders provided working capital to the amount of £140,900, and they are entitled to dividends at 7 per cent. per annum, which, for the five years unpaid, amount to £49,315. The inducement which is offered to them to give up their prior claims, and relinquish their past dividends, is the wiping out of some ordinary shares to the *nominal* value (on the reduced basis) of £6,000. It is true that the ordinary capital will stand at a small amount (£11,784) compared with the preference capital (£84,540), but the balance might at any time be adjusted by the issue of further capital. It appears to us to be inequitable and inadvisable to issue shares with prior rights, and then to extinguish those rights without adequate compensation,

We cannot find that the preferential shareholders will benefit under this scheme in any way, and on the other hand a positive temptation is offered them to present a petition to wind up the company before the articles of association are amended to admit of the proposed confiscation. The legality of the proposed alteration of the articles of association is open to considerable doubt, and we cannot help thinking that the company whose advent to renewed prosperity we should have heartily welcomed, may be by this financial manipulation laying up for themselves in the near future anything but a bed of roses.

Bedford Accounts.

THE practical result of the year's working at Bedford is a deficiency of £914 for the year. It will be seen from the cost of production that though coal figures out somewhat high, salaries and management are fairly low. No doubt with the natural expansion of the system the general working costs will be materially reduced.

The following table gives the cost per unit:—

	1896.	1895.
Total capital expended...	£38,670	—
Number of units sold	158,238	—
Number of lamps connected	—	—
Revenue from sale of current	£2,939	—
Net revenue	£842	—
Average price obtained per unit ...	4·47d.	—

Cost of Production.	£ s. d.	Per unit.
Coal	888 0 0	1·35d.
Oil, waste, water, and engine room stores	104 0 0	·16d.
Salaries and wages at generating station	610 0 0	·93d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	78 0 0 (Works' cost 2·56d.)	·12d.
Rent, rates and taxes	122 0 9	·18d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	263 0 0	·40d.
Depreciation of buildings and plant account	—	—
Renewal fund account	—	—
Total	£2,065 0 0	3·14d.

Revenue.	£ s. d.	Average price obtained per unit.
By sale of current	2,939 0 0	4·47d.
Meter rents, &c.	67 0 0	—
Transfer fees	—	—
Total	£3,026 0 0	4·47d.

Total cost per unit (exclusive of depreciation and renewal accounts), 3·14d.; works' cost, 2·56d.

Manchester Accounts.

WE referred in our last issue to the principal features of the Manchester Corporation Electric Lighting accounts, and little more remains to be done except to give the cost of production, which is as follows:—

	1897.	1896.
Total capital expended	£309,190	£251,690
Number of units sold	2,508,588	1,748,244
Number of lamps connected	—	—
Revenue from sale of current	£50,194	£37,369
Net revenue	£31,116	£20,549
Average price obtained per unit	4·80d.	5·1d.

Cost of production.	£	Per unit.	1896
Coal	4,146	·40d.	·42d.
Oil, waste, water and engine room stores	1,176	·11d.	·15d.
Salaries and wages at generating station	2,763	·26d.	·38d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	1,776 (Works' cost ·94d.)	·17d.	·27d.
Rent, Rates and taxes	2,104	·20d.	·22d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	3,289	·31d.	·36d.
Depreciation of buildings and plant account	—	—	—
Renewal fund account	—	—	—
Total	£15,254	1·45d.	1·80d.

Revenue.	£ s. d.	Average price obtained per unit.
By sale of current	50,194 0 0	—
Meter rents, &c.	1,289 0 0	4·80d.
Other items	—	—
Transfer Fees	—	—
Total	£51,483 0 0	4·80d.

Total cost per unit (exclusive of depreciation and renewal accounts), 1·45d.; works' cost, ·94d.

The Southampton Figures.

ON the whole, one can fairly congratulate the Southampton Corporation on the steady progress that is being made. Although we may take it that the real era of municipal lighting in Southampton will not commence till the completion of the new works, it is satisfactory to see that they are on the right side of the balance-sheet, for after paying interest on loan and a contribution of £508 to sinking fund, there is a balance of £21 carried forward.

The following table gives the cost per unit:—

	1896.	1895.
Total capital expended	£28,425	—
Number of units sold	131,843	—
Number of lamps connected	—	—
Revenue from sale of current	£3,409	—
Net revenue	£1,472	—
Average price obtained per unit	6·2d.	—

Cost of production.	£	s.	d.	Per unit.
Coal	639	0	0	1·16d.
Oil, waste, water, and engine room stores	75	0	0	·14d.
Salaries and wages at generating station	365	0	0	·66d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	171	0	0	(Works' cost 2·27d.) ·31d.
Rent, rates and taxes	122	0	0	·22d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	635	0	0	1·16d.
Depreciation of buildings and plant account	—			—
Renewal fund account	—			—
Total	£2,007	0	0	3·65d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	3,409	0	0	6·2d.
Meter rents, &c, ...	69	0	0	—
Total	£3,478	0	0	6·2d.

Total cost per unit (exclusive of depreciation and renewal accounts), 3·65d.; works' cost, 2·27d.

Crompton & Co., Limited.

The ninth report of the directors, to be presented at the annual general meeting of the shareholders at the City Terminus Hotel, Cannon Street, on Thursday, July 22nd, 1897, states the directors have pleasure in submitting the annual statement of accounts made up to March 31st last, from which it will be seen that notwithstanding the fact that the business is still being carried on at considerable disadvantage at the old works, the result of the year's working shows a profit. Acting upon the pledge given to the shareholders at the last meeting, the directors have prepared a scheme for reducing the capital of the company, the particulars of which are set out in the accompanying circular, and, in accordance with the notice herewith, a special meeting of the shareholders will be held at the conclusion of the ordinary business for the purpose of considering, and if approved, of passing the necessary resolution for altering the articles of association. The net profits for the year amount to £12,172 19s. 4d., and, after providing for debenture interest and the payments set out in the revenue account, there remains a balance of £4,180 11s. 5d. The new works of the company, after being considerably impeded by the wet and the tempestuous weather of last winter and spring are now practically completed, and so soon as the new machinery is erected the work of manufacture there will be commenced with every prospect of considerable economies. Notwithstanding the difficulties of manufacture in the old works, a larger business was carried on last year than ever before, and the prospects for the future are decidedly encouraging. The lease of the London Works at Lillie Road has been given up, and the manufacturing work carried on there has been removed to Chelmsford. In accordance with the articles of association, Mr. John Trotter retires from the board of directors by rotation, but offers himself for re-election. The auditors, Messrs. J. H. Duncan & Co., also offer themselves for re-election.

Statement of Liabilities and Assets at March 31st, 1897.

Capital and Liabilities.

Dr.	£	s.	d.	£	s.	d.
Authorised issue 56,000 shares at £5 ...	280,000	0	0			
Ordinary shares, 4,000 issued as fully-paid	£20,000	0	0			
Ditto 1,928 shares, £1 called £1,928 0 0						
Payments in full 24 0 0						
	1,952	0	0			
	21,952	0	0			
Preference shares, 28,180 at £5 ...	140,900	0	0			
				162,852	0	0
Debentures, 5 per cent.				83,600	0	0
Loans from bankers				35,851	19	1
Sundry creditors				39,712	6	8
Three months' debenture interest accrued				1,010	3	4
Doubtful debts and contingencies account balance ...				188	11	0
Unclaimed dividends				10	14	0
Revenue account balance				4,180	11	5
				£327,406	5	6

Property and Assets.

Cr.	£	s.	d.
Freehold property	28,880	0	9
Plant, tools, furniture, fixtures, &c.	46,946	19	0
Stock-in-trade and work in progress	71,723	13	11
Trade debtors	67,935	2	7
Investments in shares of other companies	3,909	10	0
Chelmsford Electric Lighting and other subsidiary companies	30,432	12	7
Cash at bankers and in office	8,182	11	2
Suspense account—preliminary expenses, premium on debentures paid off, and costs of issue of debentures	9,775	3	3
Patents account	13,403	4	4
Electric cooking and heating department, cost of establishing	5,166	0	0
Goodwill	30,000	0	0
Suspense account (loss by fire)	11,051	0	11
	£327,406	5	6

Profit and Loss Account for the Year ending March 31st, 1897.

Dr.	£	s.	d.
To Trading expenses (steam and electric power, labour in stores, works salaries and expenses)	15,901	8	8
„ Administration and office expenses, rents, rates and taxes, salaries, advertisements, &c.	9,404	15	5
„ Repairs to buildings and plant	625	4	10
„ Depreciation of plant and machinery, patents and fixtures	4,185	17	3
„ Balance carried to revenue account	12,172	19	4
	£42,290	5	6

Cr.	£	s.	d.
By Gross profit from trading account, pupils' premiums, and dividends on investments	42,290	5	6
	£42,290	5	6

Revenue Account.

Dr.	£	s.	d.
To Interest on debentures	4,026	16	5
„ Interest on bankers' advances	1,284	11	10
„ Directors' managing directors', trustees', and auditors' fees	2,528	12	9
„ Income tax £152 6 11			
„ Balance 4,180 11 5			
	4,332	18	4
	£12,172	19	4

Cr.	£	s.	d.
By Net profit from profit and loss account	12,172	19	4
	£12,172	19	4

The following circular has been issued to the shareholders:—

"At the general meeting of the company in August, 1895, some of the shareholders, with the general approval of many others present, urged upon the board of directors the advisability of their taking in hand the question of re-arranging the capital account of the company by writing down the value of some of the assets. At last year's meeting the directors pledged themselves to give effect to these views, and since then the failure of the Australian Company renders it still more necessary that the matter should be decided.

"After careful consideration, the directors propose to write off the debit balance of the revenue account at March 31st, 1896, and the preliminary expenses account, to write down the various investments of the company and doubtful debts, the patents accounts, and the goodwill account, the total amount thus dealt with being £78,396.

"To give effect to this they recommend the following scheme:—

"That the whole of the share capital of the company, both preference and ordinary, be reduced by writing off £2 per share from the nominal value of £5, and that the distinction between the preference and ordinary shares be abolished. As a consideration for this cession of their rights of priority on the part of the preference shareholders, the holders of the fully paid ordinary shares have consented, if the proposed arrangement is carried out, to relinquish for cancellation half (namely, 2,000) of their ordinary shares.

"It will be necessary that the uncalled capital be called up, and instead of the position shown in the accompanying balance-sheet, the future paid-up capital of the company will be £96,324 in 32,108 shares of £3 each, and there will still remain 21,892 shares of £3 each, which may be issued at some future date with the object of providing working capital.

"In making these proposals, my directors have in view the desirability of effecting an arrangement by which the profits, which are likely to be earned by the company in the immediate future, may be distributed to the shareholders, and they have therefore carefully weighed the claims and rights which both the existing classes of shareholders now possess, the ordinary shareholders on the one hand, so soon as the prosperity of the company is re-established, would be practically taking half the profits of the company, and on the other hand the preference-holders are entitled to certain arrears of dividends.

"Setting these claims and rights one against the other, the arrangement herein proposed appears to be a fair and just one.

"It should be borne in mind that in the new arrangement the holders of the ordinary shares, which originally stood at £49,640 will in the future only rank as £11,784 paid, as compared to £84,540 held by the present preference-holders.

"The directors are of opinion that the capital of the company should be written down by reducing the various assets of the company to the amount of £78,396, and unless the two classes of shareholders combine to carry into effect an equitable arrangement such as is herein proposed, it would be necessary that the whole of this amount be written off out of profits before any dividend can be paid to either the preference or ordinary shareholders.

"To those ordinary holders who will now be called upon to pay up £4 per share by instalments, and who will in return only get a certificate for a £3 share, it should be pointed out that the liability has been incurred by them, and would have to be met sooner or later, while under present circumstances, unless some such arrangement as is herein proposed be adopted, the prospects of a dividend coming to them are indefinitely postponed.

"The vendors, who surrendered 4,000 £5 ordinary shares in 1894, have now agreed to surrender a further 2,000 shares, and that the remaining 2,000 shares still held by them shall be written down to £3 per share in common with those held by other members. They consent to this as a consideration for the concession proposed to be made by the preference holders, as they believe it to be in the interests of the company that the scheme should be adopted, and it should be mentioned that they are by far the largest holders of the preference shares, for which they subscribed and paid in cash.

"Under the new scheme the ordinary holder will rank for dividend with all the other members of the company, and as the capital will only stand at £96,324 the directors look forward with confidence to the time when regular dividends will be paid, and when at the same time they may be able to build up a substantial reserve fund, which should place the company in a position of security and independence.

"As a first step towards carrying this scheme into effect it will be necessary to alter the company's articles of association by the addition of the clause set out in the notice of extraordinary general meeting herewith. Should it appear likely that you will be unable to attend the meeting, the directors request, if you approve of the scheme, that you will fill up, sign and return to me the enclosed form of proxy, as it is desirable to obtain the views of the shareholders as fully as possible.

"By order of the board,
"Francis R. Reeves,
"*Secretary.*
"Mansion House Buildings,
"London, *July 10th*, 1896."

The Electric Construction Company, Limited.

The report of the directors, to be submitted to the shareholders at the fourth annual general meeting of the Electric Construction Company, Limited, to be held on Thursday, July 22nd, 1897, at Winchester House, Old Broad Street, London, states that the company's financial year was closed, as intimated in the circular of February 27th, on May 31st, instead of, as formerly, on June 30th, and consequently the accounts now submitted cover a period of only 11 months. The net profits of the 11 months are £17,399 2s. 5d., and adding the balance brought from last year, £13,297 5s. 4d., the amount available for dividend is £30,696 7s. 9d. Your directors recommend dividends for the 11 months as follows:—On the preference shares at the rate of 7 per cent. per annum, payable on July 31st, and on the ordinary shares of 5½ per cent. (being at the rate of 6 per cent. per annum), free of income-tax, one half payable on July 31st, and the other on January 31st next. These dividends will absorb £14,197 7s., leaving a balance of £16,499 to be carried forward. The buildings and plant have been fully maintained, and adequate depreciation provided, as formerly, out of revenue. Only additions to the works or plant which tend to increase the output, or to economy in production, are charged to capital account. The development of the business continues to make satisfactory progress—the customers, men employed, output and gross profits all show important increases, and the works are full of orders at remunerative prices.

Among the more important orders recently completed, or now in hand, may be mentioned: Central station plant for Birmingham, Brighton, Bath, Halifax, Morley, Shoreditch, and Chelsea; a multipolar dynamo for the Corporation of Manchester, three times greater in capacity than has hitherto been built in this country, and an electric railway for the City and South London Railway Company. Large repeat orders have been received from the War Office, the Crown Agents for the Colonies, the Corporations of Leyton and Durban, and others. The Hartlepool tramways have now been running successfully for over 12 months, showing the capability of your establishment for electric traction work.

To meet the requirements of the growing business, your directors propose to offer a portion of the unissued share capital to the shareholders after the general meeting. It is also in contemplation to take steps to reduce the rate of interest on the company's debentures.

The directors who retire by rotation at the general meeting are Sir Daniel Cooper and Sir James Pender. They are eligible for re-election. Messrs. James Meston & Co., the auditors for the past year, offer themselves for re-election.

Globe Telegraph and Trust Company, Limited.—The directors recommend the payment of a final dividend of 3s. 6d. per share on the ordinary shares, carrying forward about £1,950.

The Direct United States Cable Company, Limited.—The board has resolved to recommend a final dividend of 2s. 6d. per share, and a bonus of 2s. per share (both free of income-tax), such dividend and bonus to be payable on and after the 20th inst., making, with the three interim dividends already paid, a total distribution of 3 per cent. for the year ended June 30th last, and after placing £4,000 to reserve fund account, carrying forward a balance of about £3,927. Notice is also given that the transfer books of this company will be closed from July 13th to 27th (both days inclusive).

The St. James's and Pall Mall Electric Light Company, Limited.—This company notifies the declaration of an interim dividend on the preference shares at the rate of 7 per cent. per annum, and on the ordinary shares at the rate of 7 per cent. per annum for the half-year ending June 30th. The sale of electricity for the quarter ending June 24th, 1897, amounted to £14,533, as against £10,657 for the corresponding period of 1896.

City and South London Railway Company, Limited.—The accounts for the half-year ended June 30th show a balance, after providing for the debenture interest and the full dividend on the 5 per cent. preference shares, sufficient to allow the payment of a dividend on the consolidated ordinary stock at the rate of 2 per cent. per annum, carrying forward a balance of £1,035 to the new account. The dividend for the corresponding period last year was at the rate of 1⅝ per cent. per annum, the balance carried forward being £1,072. The amount of £1,000, received as rent for the Jubilee stands, has been carried to a reserve account.

Eastern Telegraph Company, Limited.—This company announces that subject to final audit, the accounts show, after placing about £120,000 to reserve fund, a balance available sufficient to pay the fixed dividend on the preference shares, less income-tax, and a final payment of 2s. 6d. per share, with a bonus of 3s. per share, both free of income-tax, on the ordinary shares, making, with previous payments on account, a total distribution of 6½ per cent. on those shares for the year ended March 31st. The transfer books will be closed from July 14th to 22nd, inclusive.

Dublin United Tramways Company, Limited.—The directors have, subject to final audit, declared a dividend for the half-year ending June 30th, at the rate of 6 per cent. per annum, on the 6 per cent. preference shares, and a dividend at the rate of 4 per cent. per annum, on the ordinary shares of the company, after providing for debenture interest, &c. The transfer books of the company will be closed from the 14th to the 27th inst., both days inclusive.

Coventry Gas Fitting, Electrical, and Engineering Company, Limited.—The annual report of this company states that the business shares in the continued prosperity of the city trades. The year's working has resulted in a profit of £2,591 16s. 6d. The directors recommend that £500 be carried to the reserve, and a dividend of 10 per cent. and a bonus of 1s. 6d. per share be paid. The continued increase of business requires further capital, and the directors propose to issue £2,000 more in £1 shares, at 25s. per share.

The Charing Cross and Strand Electricity Supply Corporation, Limited.—The directors have declared an interim dividend for the half-year ending June 30th, 1897, at the rate of £6 per cent. per annum on the ordinary share capital of the corporation. The interim dividend will be paid on August 14th next.

The County of London and Brush Provincial Electric Lighting Company, Limited.—The directors have declared an interim dividend for the half-year to June 30th, 1897, on the first and second issues of preference shares, at the rate of 6 per cent. per annum, less income tax, on the amounts paid up thereon and calculated from the due dates of payment.

Telegraph Construction and Maintenance Company, Limited.—The transfer books will be closed from the 12th to the 20th inst., inclusive, preparatory to the payment of an ad interim dividend of 12s. per share to all shareholders on the register on the 12th inst.

Stock Exchange Notice.—Application has been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation to, British Electric Traction Company, Limited, 10,000 ordinary shares.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending July 11th, 1897, were £902; week ending July 12th, 1896, £937; decrease, £35; total receipts for half-year, 1897, £1,933; corresponding period, 1896, £1,818; increase, £115.

The Liverpool Overhead Railway Company. The receipts for the week ending July 11th, 1897, amounted to £1,483; corresponding week last year £1,252; increase, £231.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 9th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,443.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, July 7th.	Closing Quotation, July 14th.	Business done during week ended July 14th, 1897. Highest.	Lowest
149,900£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	99 —103 xd	99 —103	...	...
25,000	Amazon Telegraph, Limited, shares...	10	..	...	...	5 — 6	5 — 6	...	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	54 — 57	55 — 58	55⅝	55
3,038,020£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	100 —101	100½ — 101½	101½	100½
3,038,920£	Do. do. Defd.	Stock	..	...	...	10½ — 10⅝	10½ — 11	10⅝	10½
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	14⅜ — 15½	15 — 15½	15½	15
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	..	3½ — 3⅝	3½ — 3⅝	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	170 —175	170 —175	...	...
653,586£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	106½—107½	106½—107½	107½	106½
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	2 %	⅞ — ⅞	⅞ — ⅞	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	9 — 10	9 — 10	9⅜	9⅜
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½ — 4⅛	3½ — 4⅛	4⅛	4 1/16
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	9½ — 10½	9½ — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 —106 %	103 —106%xd	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	9⅛ — 10	9⅜ — 10⅛	10	9⅜
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	6½%	17 — 17½	17 — 17½	17⅛	17
70,000	Do. 6 % Cum. Pref.	10	6 %	6	6%	18 — 19	18 — 19	18	...
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5%	103 —106	103 —106	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4%	128 —131	128 —131	128½	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7%	17⅜— 18⅛	17⅜— 18⅛	18 1/16	17⅞
35,500£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	99 —103 xd	99 —103	...	...
133,100£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	100 —103 xd	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	129 —132	130 —133	...	...
51,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	99 —103 xd	99 —103	...	...
69,200£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	100 —103 xd	100 —103	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	105 —108	105 —108	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	107 —110 %	107 —110%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	4½%	11¼— 11⅝	11¼— 12	11⅝	11 7/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6%	17 — 17½	17 — 17½	17¼	17
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	10 %	10%	25 — 26	25½ — 26½	25	...
160,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5%	104 —107	104 —107	105	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10%	54 — 57	53 — 56	55¼	53¼
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 —110	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2¼	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5⅛%	5⅛%	6⅝ — 6⅞	6⅝ — 6⅞	6⅞	6⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	16⅜	16½
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6 7/16	6 1/16
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	103 —107	103 —107	105½	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	5 %	⅝ — ¾	⅝ — ¾	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	106 —109 xd	107 —110	...	...
11,839	Reuter's Ltd.	8	nil	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	135 —140	135 —140	...	...
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3⅜ - 4⅛	3⅜ - 4⅛	3⅞	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	99 —104	98 —104	102½	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	nil	4 %	nil	5 — 6	5 — 6	...	...
213,400£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	101 —104	101 —104	...	...
64,256	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	2 %	8½ — 8⅝	8½ — 9	...	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½ — 7	6⅝ - 7⅛	...	...
33,129	Do. do. do. Def. Ord ...	7½	1 %	1 %	...	2 — 2½	2 — 2⅜	2⅜	...
382,230	Do. do. do. 4 % Deb. Stock Red....	Stock	...	...	...	99 —102	99 —102	100⅛	99½
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	1 %	⅞ - 1⅛	⅞ — 1⅛	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10½ — 11	10¼— 10⅜	10⅜	10⅜
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9 — 10	9 — 10	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	105 —108	105 —108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7%	104 —108	104 —108	...	...
160,100£	Do. do. 6 % Ster. Bonds.	100	5 %	6 %	6%	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	13 — 14	13 — 14	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6¼— 6⅝	6 — 6½	6 5/16	6⅛
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	9⅜ — 10¼	9⅜ — 10¼	10	9 15/16
60,000	Do. do. 4½ % Deb. Stock Red. ...	Stock	.	4½%	4½%	110 —113	110 —113	...	...
40,000	City of London Elec.Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	23½ - 24½	23½ — 24½	24	23 11/16
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17 — 18	17 — 18	17⅜	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 —134	129	...
22,475	Jounty of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	nil	nil	12¾— 13¼	12⅜— 13¼	13	12 15/16
10,000	Do. do. do. 6% Pref., 40,001—50,000	10	...	6 %	6 %	15 — 15½	15 — 15½	15 1/16	14⅞
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	..	14⅜— 15¼	14⅜ -- 15¼	15	14 15/16
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	8½— 9	8½— 9	8⅝	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	5 %	16½ — 17½	16½— 17⅛	16 15/16	16 9/16
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	16 — 17	15½— 16½	16⅛	15½
220,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	118 —122	118 —122	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	15 — 16	15 — 16	15½	15½
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	15½— 16½	15½ — 16½	16½	16½
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	...	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 68,000 ...	5	5 %	7 %	9 %	15½— 16½	15 — 16	15⅛	15

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

§ Dividen arked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME,	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation July 7th.	Closing Quotation, July 14th.	Business done during week ended July 14th, 1897. Highest.	Lowest.
20,000	British Electric Traction	10	...	...	...	12 — 12½	11⅜ — 12½	12	...
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	2½%	...	...	1⅛ — 1⅜	1⅛ — 1⅜	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1½ — 1⅝	1⅜ — 1⅝	1½	1 7/16
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	105 —109	105 —109	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	93 — 97	93 — 97	..	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	9⅜ — 10¼	9⅜ — 10¼	10 1/16	...
143,106	Do. do. do. £6 paid	10	...	...	...	5⅝ — 6½	5⅝ — 6½	...	...
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1¼ — 1⅜	1¼ — 1⅜	...	...
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4¼ — 4⅜	4¼ — 4⅜	...	...
630,000£	City and South London Railway	Stock	1¼%	1 5/16%	1 9/16%	59 — 61	62 — 64	63	60⅞
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1⅜ — 2¼	1½ — 2	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	2¼ — 2⅜	2¼ — 2⅜	2⅜	2½
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	3½ — 4½	3½ — 4½	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	5½%	1⅝ — 2⅛	1⅝ — 2	1 15/16	1⅞
16,343	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2⅜ — 3½	2⅜ — 3½	3½	2⅜
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	⅜ — 1	⅜ — 1	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	½ — ⅝	½ — ⅝	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	18½ — 19½	18½ — 19½	18⅝	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	108 —113	108 —113	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	20½ — 21⅓	20½ — 21⅓	21⅓	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	105 —108	105 —108	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	2⅜%	2⅜%	12½ — 12⅝	12 7/16 — 12 9/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15½ — 16	15½ — 16	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	37 — 40	37 — 40	38⅜	37⅛
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105 xd	102 —105	102½	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10⅞ — 11¼	10⅞ — 11¼	10⅞	...

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.
CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1893—0%‖; 1891—3%‖ 1896—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9⅛.

Electric Construction Corporation, 6 % Debentures, 102—105xd.

House-to-House Company, 7 % Preference, of £5, 10¼—10⅜.

Do. do. 4½% Debentures of £100, 108—110.

* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 13—13½; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼—8⅜. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 1⅜—2.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8¼—8⅜. Dividend for 1896—6 %.

Bank rate of discount, 2 per cent. (May 13th, 1897).

RECENT PROGRESS IN ARC LIGHTING.*

BY ELIHU THOMSON.

IT is now six years since I read a paper on "The Electric Arc and Its Use in Lighting" before this Association. Since that time considerable technical advances have taken place in this important field, and a continuous commercial expansion of arc lighting as an industry has resulted.

We have to-day in actual commercial use, arc lamps running under quite a variety of conditions as to nature of current, regulation of the current, and conditions concerning the arc itself as a source of light.

According to the manner in which the arc lights are worked on an electric circuit, we are enabled to make several general divisions, about as follows:—

Series arcs on:
- Constant, continuous current circuits.
- Constant, pulsating current circuits.
- Constant potential, continuous current circuits.
- Constant, alternating current circuits.

Single arcs on:
- Branch of constant potential, continuous current circuit.
- Branch of constant potential, alternating current circuit.
- Compensators with alternating current.
- Constant current transformers.

It will, at this time, be scarcely necessary to dwell upon the main features of several of the cases above enumerated, as they are too well known to call for comment here. On account of the relatively higher potential demanded by an inclosed arc, and the consequent restriction of the number of lights in a series with a given permissible voltage, there has naturally resulted thus far very little real commercial use of series inclosed arcs, and where they have been on trial use they have, in most cases, so far as the writer is aware, been discontinued.

The dynamos for constant current arc lighting are not so efficient as high class, constant potential machines, but as the running of arcs with constant potential, continuous currents demands that, for steadiness or stability, dead resistance or other additional apparatus, more or less wasteful of energy, be used in the lamp branches, what may be gained in one way is likely to be lost in another.

In recent years, machines capable of working 125 to 150 arc lights in a series have been developed successfully. But the potential between terminals in such a case may be 7,000 volts—often too high for security, and in some places forbidden by special legislation. An ingenious method of employing such machines when, as in the case with the Brush machine, several commutators are present in series relation, has been devised by Mr. Green, of the Brush Company. This plan demands that separate pairs of wires be run from the machine to the switchboard for each circuit, but the unquestionable effect of the new connection is to limit the difference of potential which is possible to be manifested between any two parts of the circuit through the machine and lamps.

In such a system, evenly loaded, the highest difference of potential anywhere to be found will evidently be that required to run a series of lights looped between two successive commutators. If, however, lights are cut off one set and added to another, so as to keep the machine in full work with unbalanced loads, then the potential distribution is, of course, disturbed, and the system approaches the condition of all commutators connected directly in series, and the lights all in one series—the old plan.

The immediate future of the series arc lighting system appears to be in the development of large dynamos, up to, say, 300 arc lights each, running at such speeds that one or

* Abstract of paper read at Convention of the National Electric Light Association, at Niagara Falls, June, 1897.

a pair may be easily coupled directly to the shaft of a moderately high speed engine. The use of a regulated constant current in the series system, besides giving a simple system as to wiring, &c., is seemingly best adapted to the use of the cheaper carbons. For extended districts the series arc lighting system is still likely to hold its own; but displacement by constant potential arcs, and inclosed arcs on constant potential circuits will doubtless continue in cities supplied by underground low pressure systems with continuous currents.

There is neither time nor space to devote to the details of arc lamp mechanism for constant current circuits. There are two points, however, which may be touched upon in this connection, as tending to secure the best results. First, the variation of pull for a given variation of current in the magnets controlling the lamp should be as great as possible. Second, there should be as little as possible variation in the force required to feed or recover from feeding. The force required to be imparted to the mechanism to release the clutch, detent or escapement should be as little as possible, and but a very small fraction of the total magnetic force in a differential or shunt feeding system. Otherwise, the lamp will not be a sensitive feeder. A good lamp should feed on a variation of 3 to 5 volts, and with certain constructions, a feeding action within one-half to three-quarters of a volt variation for a 45-volt arc can be readily attained.

Two or more arc lamps are now often connected in a branch across constant potential mains or supply lines. The inevitable use of a choking resistance in series, with arc lamps run from constant potential lines, is now pretty generally understood. Without it the current in the lamp branch is unstable.

The writer has seen no more perfect result in arc lighting than can be obtained on constant potentials, with good lamps and carbons burning open arcs.

The enclosed arc of to-day merits more than a passing consideration, on account of the general interest which has arisen in regard to it among electric light engineers. The idea of burning an arc in a practically closed and relatively small glass chamber is quite old. It was known also that the carbons would burn blunt or nearly square on the ends, and would require a relatively wider separation to let the light out; that they could be made to burn relatively more or less pointed by letting in more or less air. Early experimenters in this field were met at the outset by the serious difficulty of obscurations of the enclosing vessel by deposits generally brownish, and probably due to oxide of iron, the iron being present in the graphitic carbon used in forming the carbon sticks. The writer met this difficulty in 1879, and for many years after that date there were not to be found such pure carbons as would give so little deposition as is required to work an enclosed arc practically.

Contrary to the original expectation of its promoters, the use of enclosed arcs on series circuits did not progress rapidly, and soon retrograded. Many causes besides the one of reduced capacity of lines had undoubtedly an effect. Cheap carbons for open arcs, impure carbons for enclosed arcs, breakage of inner globes—resulting in rapid consumption of carbon—obscuration of light, &c., must have contributed largely to the result.

When it is remembered that to get the best results with arc lamps on constant potential circuits, the use of rather expensive cored carbons is necessary, the saving of carbon and frequent trimming becomes a very important item and permits the employment of more expensive carbons, provided they last long enough. The high voltage demanded by the inclosed arc was soon seen to be not a disadvantage, but a positive advantage for constant potential circuits, inasmuch as it permitted the use in one lamp of a larger fraction of the total—generally 110 volts. Hence, instead of keeping down the potential, it could even be raised from 65 to 75 or to 80 volts with advantage. In fact, it may be that the exclusion of oxygen has the effect of enriching the arc flame itself, in much the same way that a slightly luminous blue flame of a Bunsen burner becomes far more luminous by cutting off the air. There may, in fact, be free condensed carbon particles in the outer layers of the arc stream highly heated and, therefore, strongly luminous. The flat ends of the carbons tend, also, to cause the hot gases to be retained under the positive end, thus extending the heat of the crater and increasing the luminosity. The result of the almost complete exclusion of oxygen is that very little combustion takes place, and the life of the carbon is therefore much extended. The function of the small glass vessel around the arc is not only to keep out the air, but, in addition, to act as a diffuser of the light evolved, and in this sense replace, to a considerable extent, an opal outer globe of large dimensions, necessarily thick and highly absorptive. The inner globe around the arc is made thin, to withstand heat without cracking from sudden changes of temperature, and is generally of clear glass with a thin coating, either internal or external, of an opal or alabaster-like glass, which, by the materials employed in its composition, gives a large diffusive effect without undue absorption. The inner globe is often also given a yellowish colour or absorptive effect for the disagreeable violet rays, of which the long arc flame is so strong a source.

Owing to the traverse from side to side of the arc between the square-ended carbons, the direction in which light is emitted from the arc most effectively is undergoing continual and very great changes, so that the intensity of light in any given direction may, in a few seconds, vary several hundred per cent., and with a perfectly clear glass inclosing globe this variation would not only be quite noticeable, but in many cases intolerable. The diffusive power of the glass, however, is such, in the case of the opal coating, that the travelling of the arc is, in large measure, compensated, and the general effect is that of a very steady, uniform light. Were it not for the diffusive power, the colour of light, as well as the intensity, would change greatly; as when the arc happened to be on the side of the carbons away from the observer, the light would then be in greater proportion from the purple or violet arc flame, and less from the glowing ends of the carbons themselves.

The carbons to be used in an "inclosed arc" should be of the very highest grade as to purity, not too hard or dense, as straight as possible, uniform in diameter and circular in section, and should be obtained of as near a standard diameter as possible, so as to avoid the necessity for adjusting the caps of the inner globes to the size of the carbons. It is necessary that the caps should fit pretty closely around the carbons to avoid leak and consequent reduction of life. Leaks of air into the inner globe must be carefully avoided, if any reliance is to be placed upon a lamp for a given run without recarboning. During the run the upper part of the inner arc inclosing globe is coated slowly with a deposit, nearly white in colour when the carbons are free from iron, and consisting of what little mineral matter has been left in the carbons. Fortunately the hot uprising currents from the arc deposit considerable of this on the cap above, and return to the arc to be reheated, and again circulated at a little above the level of the arc itself, and as the lower carbon consumption gradually causes the arc to descend, the light of the arc continually reaches portions of the glass wall, which have been but slightly obscured by the deposits from prior burning. In general, the deposit which forms on the inner globe can be wiped off or dusted off at the time of recarboning. Carelessness in this particular may easily result in a large proportion of the light of the arc being lost, and what is perhaps worse, the radiant heat and light of the arc being unable to escape, goes to overheat the glass of the inner globe, either melting or deforming it so as to produce leaks, cracking it directly, or burning the deposits into its surface. After this they can only be removed by such agents as hydrofluoric acid applied to the surface.

(To be continued.)

THE MUNICIPAL ELECTRICAL ASSOCIATION, 1897.

(*Continued from page* 64.)

ELECTRICITY METERS.*

By T. P. Wilmshurst, A.I.E.E., Borough Electrical Engineer, Halifax.

In any electricity supply undertaking, one of the most important of the items which make up the distributing system and the connecting link between the technical and commercial sides of the business, is the meter.

* Read July 1st, 1897.

In considering the specification of a perfect meter, the following conditions should be classed as "essentials":—

(1) Accuracy. (2) Reliability. (3) Durability. (4) Low starting current. (5) Noiselessness. (6) Impossibility of being tampered with by consumers. (7) Unaffected by stray magnetic fields. (8) Reduction of moving parts to a minimum. (9) Small loss of power. (10) Absence of clockwork, liquids likely to freeze, mercury, contacts, or commutators. (11) If energy meters, should measure true watts. (12, 13, 14, 15) Must be unaffected by vibration, alteration of temperature, frequency (if alternating), or barometric pressure.

In addition, the following may be classed as "desiderata".—(16) Equally correct for direct or alternating currents. (17) Capable of being checked by a short time test. (18) Low cost.

Although "low cost" has been placed at the end of the list, it is not to be implied that its relative importance is smaller than other items to which more prominence is given.

Some of the above points may well be amplified and discussed.

1. Accuracy. Before defining what we should consider a commercially accurate meter, let us for a moment inquire what, in the case of parallel undertakings, is considered an "accurate" meter.

The Sale of Gas Act, requires that "no meter shall be stamped which shall have an error of more than 2 per cent. in favour of the seller, and 3 per cent. in favour of the consumer," and the author believes that when new, at any rate, all the well-known gas meters are within this limit.

In the case of water meters, there are no limits fixed by Parliament. The best makers, however, will guarantee their meters to have a variation not exceeding 2½ per cent. from the mean (an extreme range of 5 per cent.), though the accuracy seems to fall off somewhat rapidly at low loads.

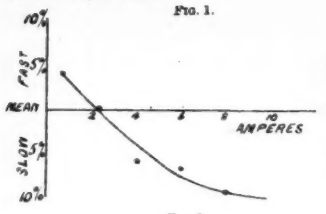


Fig. 1.

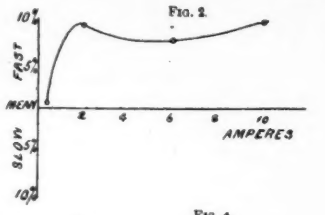


Fig. 2.

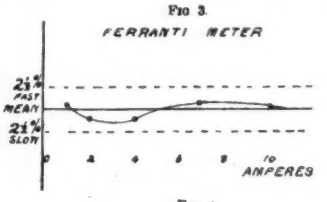


Fig 3.

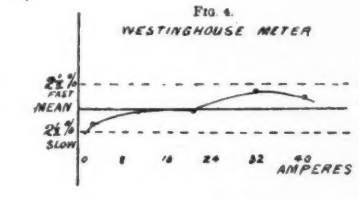


Fig. 4.

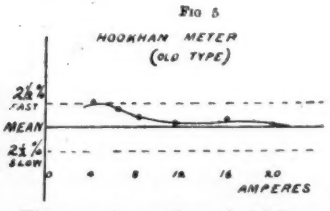


Fig 5

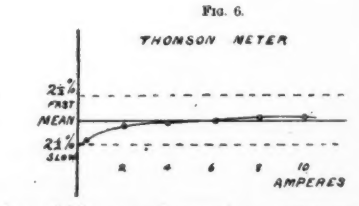


Fig. 6.

There are few modern electricity meters which are not correct within the above limits. The author has adopted the following standard of variation, and almost all manufacturers appear to be able to easily comply with the specification.

At full or half load	...	2 per cent. from normal.
At quarter load ...	...	3 " "
At one-tenth load	...	4 " "

And no meter is accepted in which this variation is exceeded.

So far as the author is aware, no definition of a "correct" meter has yet been given by the Board of Trade.

The rules of the London County Council contain the following:—"A meter shall be considered to be correct when the registration shown by the dials is within 2½ per cent. of absolute accuracy at all points above $\frac{1}{10}$th load, or 1¼ amperes."

To obtain this extreme accuracy, it need hardly be observed that the working of the meter should be based on what might be called a straight line law, and should not be "cooked" by numerous compensating devices to approximate correct readings, otherwise errors are extremely likely to creep in after a time.

(2 and 3) Reliability and durability. Not only must the meter not show traces of undue wear and tear, but it should be impossible for the curve to alter appreciably after a lapse of time.

Time alone will decide what constitutes a fair rate of depreciation. In this connection, the writer notes with satisfaction that several of our manufacturers have abandoned the thin tin case in favour of a more substantial one of cast-iron.

It is almost an impossibility to make even a moderately dust-tight joint where a tinned iron cover is used. Another weak point is the use of iron for the worm connecting the revolving spindle to the first wheel of the registering train. In many towns, the worm is apt to rust after a short time, involving a serious loss of speed. The use of phosphor bronze is much to be preferred. Low speed is probably also an important factor in the question of durability.

4. Low Starting Current. A good meter should start without fail, on not more than one-fiftieth of its maximum load. In this respect the energy meter as distinguished from the quantity meter seems to have a decided advantage.

It is a matter of some interest to study the means adopted to ensure a low starting current. One maker adds a shunt coil which, though solving the initial friction difficulty, introduces the losses inseparable from a shunt winding.

Another obtains extreme accuracy at low loads, partly by the use of a shunt coil, and partly by making the lower jewel self-adjusting, the upper end of the spindle being held by a loose guide.

A third shields the lines of force passing through the magnet and brake disc by interposing a copper plate, the eddy currents in the plate re-acting on those in the movable disc, setting up a mutual attraction.

A fourth has arranged that the disc shall float on mercury at low loads, the weight of the spindle being therefore entirely taken off the lower bearing.

10. Absence of clockwork, &c. It is hardly necessary to observe that any form of meter that requires periodical winding up, should be avoided. Contacts and commutators, though working well for a time, will eventually be a source of trouble. The use of mercury, unless entirely enclosed, is a disadvantage. A momentary short circuit is liable to cause the mercury to fly about inside the meter, even penetrating to the train of wheels.

12. Vibration. With most forms of meter the effect of vibration is to considerably raise the curve at low loads; above one-fifth load the effect is practically nil. A moderate amount of vibration such, for instance, as is met with in a mill where the thud of machinery is perceptible, is sometimes sufficient to cause an energy meter to run on its shunt alone, if adequate precautions be not taken.

13 and 14. Alteration of frequency and temperature. Experiments to determine the effect of alteration of frequency on alternating current meters were published by Messrs. Cowan & Still two years ago. The results arrived at show that the variations of frequency, due to the variations of speed met with in alternating stations, have practically no effect on the correct reading of the best known meters. The author's experiments in this direction, and also on the effect of change of temperature, entirely confirm the conclusions of the above-named authors.

A few words may now be said on the highly debatable question of quantity *versus* energy meters.

The principal advantage claimed by the advocates of the quantity meter is the small loss of power in the meter itself, and this is undoubtedly a powerful recommendation in its favour. A quantity meter, however, usually exhibits the defect of requiring a somewhat large starting current, involving a loss of revenue at light loads. To obviate this defect, some makers have avoided Scylla only to fall into Charybdis by adding the much-condemned shunt coil to obtain a large initial torque. If this expedient has to be resorted to, the advantages of the quantity meter over the energy meter are largely discounted.

It seems to be a fact, however, that the direct current quantity meter is considerably better in this respect than the alternating current meter.

In alternating systems, needless to say that on inductive circuits one has no option, and nothing can be used but an instrument measuring true watt-hours.

There are several so-called energy meters on the market, which hardly deserve the name. One type when used on arc lamp circuits runs considerably slow; nor is this all, for if sufficient inductance be introduced into the circuit, the direction of rotation of the meter will actually reverse. This fault will have to be eliminated before this type of meter can be considered to approach perfection, as a consumer has only to switch on a choking coil across his mains on retiring to rest, in order to wind back the units he has consumed during the evening; he may even go further than this, and present an invoice to the undertakers for current supplied to them!

It may be urged that the vast majority of consumers on alternating circuits have non-inductive loads; as, however, it is probable that consumers will gradually introduce small motors and domestic appliances, the power factor of which is less than unity, it would appear to be the wisest policy to use true watt-hour meters, provided always that the shunt losses are so small as to be negligible.

In considering the magnitude of the shunt losses, it should be borne in mind that these losses, unlike the main coil losses, are evenly spread over the 24 hours. The cost of maintaining the shunt, therefore, should not exeed ¾d. per unit. In the author's opinion too much importance is often attached to these shunt losses. Arguments by hostile critics often assume that these losses are as high as 10 or 12 watts, and therefore that an energy meter must be a very wasteful appliance.

The following figures show the actual shunt losses in various modern meters:—

Hookham alternating meter	...	...	1·5 to 2·5 watts.
Thomson watt-hour meter	...	...	2·3 to 3·3 "
Westinghouse watt-hour meter		...	1·3 "
Edmondson zero-torque meter		...	1 "
Electrical Company's meter	(about)	...	1 "
Scheeffer	(about)	...	1 "

These figures are approximately correct, but vary somewhat for different sizes.

The main coal losses, on the other hand, are as a rule quietly ignored. It is by no means an unknown thing for the $c^2 R$ losses to be between 12 and 16 watts, and these losses have their maxima at times of heavy load when their importance is relatively great. In the case, therefore, of an installation in which there is a heavy

demand for long hours, the main coil losses may quite possibly far exceed those in the shunt.

While on this subject, it may be well to note that the only meters which have yet received the approval of the Board of Trade, are those in which a shunt coil is absent.

The most serious objection to the energy meter, and one which is far more important than the shunt losses, is the possibility in this type of running on the shunt alone.

The author has observed this defect in over 6 per cent. of the energy meters received from the makers. The great importance of the point lies in the possible loss of confidence of the consumer in the apparatus, the correct registration of which determines his quarterly bill.

In the Thomson meter, as is well known, a large initial torque is obtained either by fixing one terminal of the shunt on the lamp side of the main coil, this ensuring a sufficient field to just counterbalance pivot friction, or by fixing it on the supply side and using a subsidiary coil inside the main coil, thus giving an initial field when no current passes through the field coil.

The refusal to run on the shunt depends, therefore, upon the energy absorbed at no load exactly counterbalancing pivot friction.

In the Hookham alternating current meter, as mentioned before, a large initial torque is obtained by the interaction of a copper shield and the brake disc. An ingenious device is used to avoid shunt running by fixing a small piece of iron on the disc when this travels under a subsidiary brake magnet, the mutual attraction prevents the disc travelling further until the main circuit of the meter is closed through a lamp. Neglect of this simple precaution causes the meter to run on the shunt to the tune of over 140 units per annum.

In the Edmondson alternating current meter, the principle of which is similar to the Siemens's dynamometer, the torsion of a spring is balanced by the torque due to the attraction between the main and shunt coils. The shunt forms a closed circuit, and when the lamp circuit is open no current can pass through the main coil; there is no initial torque, and no registration can therefore possibly take place.

In spite of the fact that there is no initial torque until the lamp circuit is closed, the meter commences to register at $\frac{1}{100}$th of its capacity, and is, moreover, extraordinarily accurate throughout its range.

In the new Westinghouse watt-hour meter, described later, the working of the meter depends on the phase difference produced between the main and shunt coils. Unless the main coil circuit is closed through a lamp, obviously there can be no phase difference and therefore no rotation.

At the present time the number of meters in use in this country is somewhere in the neighbourhood of 100,000. Of these about 70 per cent. are quantity meters, 30 per cent. being of the energy type. It is perhaps only natural that the direct current station engineer should not attach so much importance to the use of an energy meter as the alternating current engineer, especially when the average voltage kept up does not exceed the declared pressure, and one finds, therefore, that in direct current stations the quantity meter largely preponderates.

In alternating current stations, some idea of the relative esteem in which the two types of meter are held may be gained from the fact that there are about 25,000 quantity and 20,000 energy meters in use.

A large number of alternating station engineers have been good enough to favour the author with their views on the question, and from the mass of information so obtained, it is clear that there is a preponderance of opinion in this country in favour of the energy type, though in some cases the preference is so far only of the nature of a "pious belief."

One engineer is so pleased with his energy meters, that "in three weeks we shall not have a quantity meter left in the place." Another writes:—"In our opinion, all meters should be energy meters."

A third naïvely admits:—"We prefer the wattmeters, because they scrape up most current."

Another gentleman writes:—"I should always prefer to use wattmeters, more especially in scattered districts, where at some points you are supplying at, say, 105 volts, and others at 100 volts."

The present writer abstains from giving any clue to the identity of this gentleman, as he might receive attention from the Board of Trade for neglecting to comply with the rules of that department!

The quantity meter has, however, no lack of advocates.

One engineer writes:—"My experience is that the quantity meter, with all its faults, takes a lot of beating yet."

Another writes:—"Our quantity meters are very satisfactory, and it is a great consideration having no waste, all-day, shunt current." A third uses quantity meters entirely, on the ground that the losses are so small, and that there is so little to get out of order.

An interesting suggestion has been made by one prominent engineer, who writes:—"For non-inductive loads we prefer the cheapest and simplest meter, assuming the load to be constant, and within the limits of accuracy of either type of meter, and when the range required entails a loss by using a current meter, we compare the loss with the cost of supplying energy for the shunt of a watt-meter and decide accordingly."

The most commercial method of attacking the problem undoubtedly is:—Which type brings in most net revenue?

With the idea of attempting the solution of this question, the author made a number of experiments with a quantity and energy meter in different premises, under varying conditions, with results as follows:—

1. Installation of about 100 lights, 6 to 10 lights in use the whole 24 hours, 60 to 70 lights in use an average of 12 hours per day. Average voltage 102.

Energy meter	1,445 units.
Quantity "	1,375 "

2. Office lighting only; 1 or 2 lights in use 8 hours per day, 8 lights in use 2 hours per pay. Voltage 101.

Energy meter	23 units.
Quantity "	18 "

3. Shop window lighting only; 10 lights in use about 4 hours per day. Voltage 101.

Energy meter	41 units.
Quantity "	40 "

At the same time, the shunt losses to be debited to the energy meters for the periods under test amount to only 2·5, 1·5, and 1·5 units respectively.

Before leaving this subject, a brief description of an energy meter which the author has recently had an opportunity of testing, may be of interest. This meter is made by the Westinghouse Company, and measures true watts on alternating circuits under almost all conditions met with in practice.

The meter consists of a rotating disc of aluminium, on the upper side of which is placed the shunt coil. In series with this is an induction coil, so adjusted as to produce a field lagging 90° behind the impressed E.M.F.; underneath the disc are placed the two main coils. These three coils are so placed that they each generate current in the disc, and the position of the fields produced by them is such that attraction and repulsion occur between them and the currents they generate in the disc.

This causes the disc to revolve, and the tendency to revolve is at a maximum when the field produced by the series coils differs 90° in phase from that produced by the shunt coil, which is the case when the circuit to be measured is non-inductive. Should there be induction in the circuit, a lag will be produced in the series coils, causing the field produced by them to approach that produced by the shunt coil, which remains 90° behind the impressed E.M.F. This being so, the tendency to revolve will be reduced proportionately to the lag, and so on, until a lag of 90° is arrived at, when the field produced by the current coincides with that produced by the shunt coil, and the disc will then remain stationary.

The following figures show the performance of the meter under different conditions:—

100 ampere capacity.
Starts with ·25 amperes.
Drop in main coil, ·1 volt.
Loss in shunt, 1·3 watts.

Load.	Non-inductive.	Inductive.
10,000 watts	− 1·41 per cent.	
7,500 "	+ ·12 per cent.	
5,000 "	+ 1·58 per cent.	
2,500 "	+ 2·29 per cent.	
1,000 "	+ 1·16 per cent.	
6,656 "	Power-factor ·84	+ ·33 per cent.
3,861 "	" ·8	− 1·74 per cent.
1,355 "	" ·81	+ ·58 per cent.

Briefly therefore the points of this meter are:—

Great accuracy on any alternating circuit.

Impossibility of reversing, due to presence of considerable induction.

Small losses.

Strong construction, cast-iron cover and double sealing arrangement.

No moving contacts.

Shunt running impossible.

TESTING.

Needless to say all meters should be tested at the supply works before being sent out to a consumer's premises.

That this is necessary is shown by figs. 1 and 2, which show the curves of meters as actually received from the makers.

As might be expected, the meter, the curve of which is shown in fig. 1, runs somewhat freely on the shunt.

These cases are, of course, very exceptional, and as an antidote, figs. 3, 4, 5 and 6 show the degree of accuracy commonly obtained by the best known meters at the present time.

The works tests should include the following, and a record should be kept of all tests.

1. Accuracy at tenth, half, and full load.
2. Starting current.
3. Running on shunt.
4. " with slight vibration.
5. " with slightly increased volts.

Incidentally it may be mentioned that where any meters are found running on the shunt, the defect may be often remedied by the simple expedient of fixing the meter about ¼-inch out of level. This method has the advantage of not causing any sensible difference in its accuracy.

6. Watts lost in shunt (if any).
7. Drop of volts in main coil at full load.
8. Insulation of meter.

In the case of quantity meters they may be strung in a series, a large number being thus tested at once.

In similarly testing energy meters, special precautions must be taken, by running a separate shunt return back to the source of supply, otherwise two errors creep in, (1) at heavy loads the pressure at the terminals of the shunts is less in each successive meter, and (2) the main coils of the meters nearest the source of supply receive more current than those at the lamp end.

All meters should be tested, if possible, with the cover in position. Neglect of this may cause a serious error. In conclusion the author wishes to express his indebtedness to Messrs. Ferranti, British Thomson-Houston, the Westinghouse Company, and Chamberlain and Hookham for the kind assistance they have given him in the preparation of his paper.

PREPAYMENT METERS.*

By H. W. COUZENS., A.I.E.E., Borough Electrical Engineer, Taunton.

THOSE electricity supply undertakings of municipalities which have been in operation for a few years, have reached a definite stage in their growth when they have to consider seriously the extension of their undertakings. Their stations have been built, and their mains have been laid, with the object of supplying primarily the crowded business portions of the towns, and during the first two or three years their hands are full connecting up the customers who are eager to have their shops and offices supplied. But at the end of that period they have gleaned most of their harvest here, and to maintain the rate of increase of their lamp connection, they have to seek fresh woods and pastures new.

There are two extensions which immediately suggest themselves, viz., the outlying suburban districts on the one hand, and the thickly populated districts on the other. At the present time the tendency is to cater for the former and to neglect the latter. This, the author will endeavour to show, is neither a wise nor a proper policy. The extensions to the outlying districts require very large expenditure on mains, and possibly some change of system. The capital outlay per consumer is very great, as the houses are more scattered, and the revenue per lamp connected is low, as it will be largely residential lighting where the maximum demand will not exceed about one-third of the number of lamps installed. But there is in the poorer districts, which are usually much nearer the supply station, a class of supply where the number of lamps installed is practically a register of the maximum demand, which demand is used with unfailing regularity from dusk to 10 or 11 o'clock, or even after, and where, with the prepayment meter, may also be secured that great commercial desideratum, viz.—cash with order.

The poorer districts are quite unable to become ordinary customers of the electricity supply department. But they would like to have the light if they could, and it is in many ways essentially the "poor man's light."

Further, the Corporation has a duty to perform to these less wealthy members of the community: they are ratepayers (directly or indirectly), and they form the backbone of the municipality. With town's water, she considers herself bound to supply them, and with the electric light, as the safest, healthiest and best illuminant, she should consider it no less obligatory on her to furnish a supply.

It may, indeed, with judicious care, be made a source of great profit as well as a duty, but it must be worked in the right way.

It is evident that the people themselves have not the money to spend in installation, and if they had they would not care to lay it out in this way, as their tenure is so precarious. The landlords are not likely to go to the necessary outlay, and so a free-wiring scheme forms a necessary corollary of extensions in these districts. The prepayment meter is even more of a necessity, and is the only thing which will make such extensions commercially possible.

Consumers of this type, in which the weekly wage earning class is predominant, cannot stand the strain of a quarterly account, but can usually find a small coin to obtain their light as wanted. The prepayment meter further solves the vexed question as to the cost of the wiring, for the payments can be adjusted to cover the interest and up-keep of the installation, which will, of course, be only trifling. The gin palaces and small shops, which abound in such neighbourhoods, will hail such a scheme with delight.

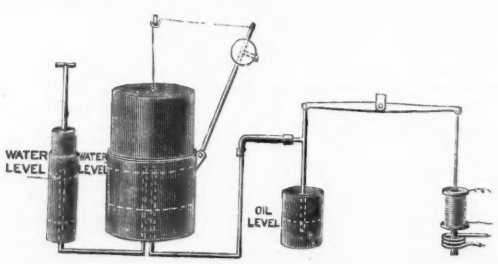
All these consumers will have a small number of lamps installed, but will burn them for a long time. The essential feature for the electricity department to bear in mind is that the cost of connection and of the prepayment meter must not be great. The former difficulty can often be met by making one connection for a block of houses and getting the necessary permission to carry the wires through the party walls, which should not be a difficult matter for the Corporation to obtain. With regard to the prepayment meter, the cost of this will be considered later, and should be about half the listed prices of average meters at the present time.

But, beyond the poorer classes, there are many shopkeepers, and residents, too, who will also hail the prepayment meter with delight, as they would far rather pay as they go, and thus know how they stand, than have a quarterly account, and electric supply companies, as well as corporations, will shortly be largely taking up this question of prepayment. For offices, for instance, where the daily consumption is very small, and where each two or three rooms has to have its separate meter, the prepayment meter possesses many obvious advantages. Many people also view the electric light with disfavour, as it is to them a new thing, and they do not feel sure as to what it will cost. They would far rather pay a fixed price per lamp per annum if they could. With the aid of this device, if the current is charged for at 6d. per unit, one has only to tell them that an 8 candle-power lamp will burn for 5½ or 6 hours for 1d. and they will be delighted with it.

Prepayment devices or coin-freed (so-called automatic) apparatus of all kinds have been one of the noteworthy features of the last decade. First brought forward apparently for the sake of sweetmeats, the principle has met with such general favour that examples are seen at all railway stations and places of amusement and recreation. The essential principle that a coin when in the slot shall release or actuate the mechanism for a particular purpose and then lock it again, is so familiar, and examples may be seen on any so-called automatic weighing machine with a glass front, that the author will not take up the time of the Association by dilating upon it, suffice it to say, that the idea has been taken up by the gas companies within the last few years and has proved an immense success in purveying small quantities of gas to the poorer classes. The author is informed that the London Gas Light and Coke Company alone had, a short time ago, over 150,000 consumers on this system upon their books, and between sixteen and seventeen thousand more waiting their turn to be joined up.

There are certain essential features of a prepayment electricity meter which the author will now proceed to consider. Firstly, he reiterates that it must be cheap for, as has been already referred to, the number of lights on each meter will usually be few, and the revenue earned will be small, and to be productive of gain, the capital outlay per consumer must be kept down. The author suggests 40s. as an acceptable price and 50s. as an outside figure, and considers that an expression of opinion from the Association will be desirable in the matter, that manufacturers may know what is expected of them. Further, the meter must be of a reliable nature, solid and strong, with as few parts as possible, as it will not be put under a glass case, and may, indeed, be treated on occasion with more vigour than respect. It should also be capable of storing up several "penn'orths" (or whatever the unit of payment may be), so that advantage may be taken of any desire on the part of the customer to provide against a rainy or foggy day. It is essential that it should be fairly accurate, though an error of one or two or even five per centum is better than a high price and absolute accuracy. It is further, more in accordance with the ideal, that it should be a wattmeter rather than an ampere hour indicator, as any deviation of the voltage from the normal will have an appreciable effect on the duration of the pennyworth. It would, perhaps, be premature and idle to expect to get this condition fulfilled at present at the proposed price, but it should not be lost sight of in future developments. It must also be proof against being tampered with, and there must be no practicable means by which ingenious contrivances can be made to extract an unlimited supply with a single coin, as is the case with the automatic sweetmeat machines at present. The prepayment meter will not have the advantage of the public gaze to defend it from these frauds.

The evolution of the prepayment meter will be watched with solicitous interest by electricity supply engineers, whether connected with municipalities or companies. To the former, however, it should appeal more strongly as enabling them to fulfil their obligations to the whole of the ratepayers. They are further in a better position to undertake extensions of mains for this supply, as they should always reckon on the connection of all the public lamps *en route* to form the nucleus of a remunerative load. On the other hand, companies are able to adopt a more forward attitude as they are untrammelled by the question of the correctness of using the public funds for installations on private premises. Some, there may be, who will doubt whether the Local Government Board will grant permission for a loan of this kind, for it is evident that free-wiring forms



a *sine quâ non* of the programme. But though they may impose a somewhat shorter period for the repayment of the loan, the author cannot see why they should object. Ample arrangements to secure the safety of the money laid out should be obtained by judicious negotiations with the landlords, and Sec. 25 of the Electric Lighting Act of 1882 fully protects both meter and fittings from distress and distraint for rent.

The author is informed that there is legally no obstacle to a Corporation undertaking this work and borrowing the money for it, and that chairman who first pilots such a scheme safely through a voyage in committee and council will confer a great benefit on municipal electric lighting throughout the country. Though there has been no movement in this direction at present, the blame cannot be laid upon electricity supply engineers, as the author is convinced that they are only waiting for a meter having a modicum of the qualities enumerated, to take it up assiduously and develop this fruitful ground for electric lighting. Apparently they will not have to wait long. The air is thick with rumours of apparatus just at or beyond the patentable stage, and a few months may alter the aspect of affairs completely. Meantime there are several developments which will repay consideration.

The first practical forward step towards the realisation of the prepayment meter was the invention of Bastian and Hodges, whose patent No. 2,224 of 1896, describes what is really a prepayment device attached to an ordinary meter. This constitutes a kind of half-way house between the ordinary meter and the prepayment meter pure and simple. The mode of working is as follows:—The insertion of a token or coin of the proper size in the slot enables the operating rod to be pushed forward by the push-piece which projects outside the case, and which without the penny will slide over the

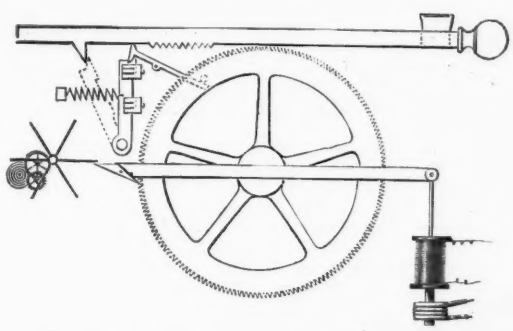
* Read July 1st, 1897.

operating rod without pushing it forward. When this is done the penny falls down a shoot into a receptacle. The movement of the operating rod pushes over a catch against the resistance of a spring. This allows two contacts to dip into mercury, and so complete the circuit. At the same time a small tooth engages a wheel, and winds up a weight through a measured height. This weight is hung over a pulley, which gears into the clock-work of the meter, and gradually descends as the current passes through the meter. By the time that the pre-arranged quantity has been consumed, the weight has descended on to two contacts, thus completing the local circuit of a small electro-magnet, and this attracts its armature, releasing a lever catch, which allows the arm dipping into the mercury to fly out and cut off the supply of current. The number of pennies that can be put in at one time is only limited by the height to which the weight can be wound; practically I believe it is about 12.

The disadvantage of this apparatus is that its cost is altogether beyond what has been laid down by the author as practicable, and probably that is the reason why the meter has not, to the author's knowledge, been bought by local authorities. It is, however, exploited by a syndicate in connection with a scheme of free wiring, and they have connected up or have on order some 5,000 lights on this system in the St. Pancras Vestry's district alone. They are also commencing operations in the town with which the author is connected, and have already fixed up a few meters. This movement, if it serves no other purpose, will draw the attention of municipalities to the great field which will be opened to them by the advent of a pre-payment meter, possessed of sound commercial and electrical qualities.

Regarding solely pre-payment meters, though at present there are none actually on the market, almost everyone, as indicated before, has some type or other just emerging from the chrysalis stage. Some work on the voltmeter principle, some are electric clocks; in a word history repeats itself, and the earlier experimental types of recording meters are reproduced (without the dials) for the sake of recording quantities, and instead of the dial we have the prepayment mechanism. The field is indeed wider than with ordinary meters, for only small quantities have to be measured, and elaboration of detail is not necessary.

The most promising of the forthcoming pre-payment meters is the one which is patented in the names of Ellis and Atherton. The former gentleman, well-known to the members of the Municipal Electrical Association as the able and enterprising chairman of the Portsmouth Electricity Committee, has devoted a considerable amount of time and skill to the invention of these meters. His earlier labours resulted in a meter which would have been quite practicable, but which has been discarded owing to more promising



developments. It consisted of a small air pump connected by a glass tube to a gas-holder, and the action of putting in the penny gave the pump one stroke and pumped one pennyworth of air into the gas-holder. This latter was also connected (as per sketch) through a flexible tube, with one end of a balance scale, dipping into a vessel containing oil. On the other end of the balance was hung the soft iron core of an electro-magnet, with a series shunt winding. The series winding was at the bottom, and when the current was utilised (after the insertion of a penny) it sucked down the armature, raising the tube at the other end of the beam, and allowing the air to escape more or less rapidly from the gas-holder. When all the air had escaped, a contact was made, and the current was cut off. The varying weight of the gas-holder dipping in the water was compensated for by another weight hung from it at a particular angle by means of pulleys.

In the improved form of meter, however, the liquid is done away with, and what is practically an intermittent integrating ammeter takes its place. The whole apparatus is very simple and ingenious, and seems to promise to achieve great success. The vital parts consist of a small American clock with a special star wheel, containing six arms shaped like the Mordey alternator field magnet, attached at one end, a large wheel or disc with a milled edge and a catch to engage this, which is connected by a long arm to the current regulating device, which is an electro-magnet similar to the one used in the previous meter. The mode of working is as follows:—The operation of putting in a penny enables the operating rod carrying a ratchet to engage the big wheel, and move it round a twelfth of its circumference (the instrument will therefore store up 12 pennyworth), and at the end of its stroke it makes a contact and switches on the current, the switch being held in position by a small catch which is released by a pin on the big wheel when it has come back to the end of the pennyworth. On the return or back stroke of the operating rod it makes another contact at the other end of the instrument, the effect of which is to let into circuit a small electro-magnet, which starts the clock and also lifts the hinged arm containing the catch previously mentioned, through a distance depending on the amount of current used by the consumer. As each star on the wheel of the clock comes over it touches a light pawl, making the catch engage with the main wheel, and carry latter forward till the pawl comes against a stop, and the catch springs off the main wheel and back to the position taken owing to the current. This operation is repeated until the pennyworth is consumed, when, as aforesaid, the pin on the main wheel comes round and knocks off the switch. This also cuts off the supply of current from the other magnet and stops the clock. There is further, a little disengaging lever which works on the back (or outward) stroke of the operating rod, whose function is to prevent damage to the catch on the main wheel supposing it stops when the star on the clock wheel is causing it to engage with the main wheel. The clock, which is an 18-hour one, is wound up by the consumer, and if allowed to run down the catch which puts on the first switch will not make contact, but slides over. He then has to wind up the clock and put in another penny, when contact will be made, and he will also get two pennyworth of light. This description is not so clear or full as the author would wish to have made it, owing to the patent rights not being fully secured at the time of writing the paper, but he trusts that sufficient has been said to give the Association some idea thereof. This meter has much to commend it, and the author predicts that when put upon the market, it will meet with prompt appreciation from electricity supply engineers.

In conclusion, the author has endeavoured to show that the pre-payment meter will open up fields for electric lighting, the importance of which has been left quite in the back-ground, and that municipalities are, or should be, most deeply interested in the development of these fields. He trusts that the Association will take the matter up, and by a vigorous expression of opinion, show manufacturers what they want, and let them know that they will eagerly welcome a good pre-payment meter. From the results which the inventive skill of electrical engineers have already achieved, there need be no doubt that the supply engineer will soon be able to choose from several good and ingenious types of instruments, each fulfilling all the stipulations and conditions he has laid down.

TECHNICAL EDUCATION IN GERMANY.

In these days of Board Schools, when we are approaching rapidly to the time when every child is to have the chance of becoming a Hallé or a Liszt, the movement started by Professor Klein in Germany is not without interest. His idea is that those who have shown special ability should be enabled to increase their knowledge and their power of using it. The Professor's description of the aims of the proposed Institute is stated by *Nature* as apparently being nothing more than a description of what might be carried on at many of the higher technical schools, and Klein's project has accordingly been very severely criticised. The criticisms all point to a feeling of antagonism between the technical high schools and the universities, which are stated to have remained uninfluenced by the change that has come over Germany and affected the technical schools in common with everything except the universities, which are looked on with contempt by engineers.

The technical high schools demand that the mathematical and science teachers should be educated by them and not by the universities, and that money given to the latter by the Government would be wasted. Klein's idea seems to be in the direction of the secondary education of which we hear so much at present.

The engineering course in Germany usually extends over four years, and students enter at about 18 years of age, after a year spent in works. This age is felt to be too great, and the technical professors call for better preparation at school so that elementary mathematics and physics may be omitted from the higher course. Professor Riedler, a well known man, asks for Professors who can teach the higher mathematics.

Our contemporary asks where such a man can be found who is also an engineer, and says this is where Klein comes in. His plan would help to educate such men. He would reunite theory and practice and put the universities in their proper place in modern German life. They should remain the chief educators of the mathematical and science teachers. He would also have all teachers better prepared in science and of higher ideals of the value of practical work. He would in fact imbue everybody with modern notions, and direct the energies of university teachers in a direction where they will be of direct value to engineers. Important English papers are to be made accessible to German physicists, and a beginning is to be made with the translation of Osborne Reynolds's paper on the friction of lubricated bearings, and Routh's Rigid Dynamics.

Klein indeed appears to hold the position in Germany that is held by Reynolds in England, of a professor not out of touch with practice, and at the same time not soiling his hands in trade, but working as a professor for his pupils—not employing his pupils to work for him. Should he succeed in his aims, for the accomplishment of which he is invoking private munificence, it is suggested that if German engineers try to starve his undertaking he will receive support from the students of England and America. At Gottingen too he would find a centre suitable both by tradition, environment, and locality for his endeavours.

SINGLE-PHASE MOTOR INSTALLATION.

By ERNEST KILBURN SCOTT.

An interesting example of the single-phase asynchronous motor is to be seen at the Semaphore Tower next to Victoria Pier, Portsmouth, where a 6 horse-power Oerlikon motor is used for pumping sea-water into a 17,500 gallon tank. The motor has two self-oiling bearings, and fast and loose pulley with third bearing and striking gear, and it drives, by means of a 5-inch leather belt, a centrifugal pump with 100 mm. openings. The motor is supplied with current at 50 periods per second from the Corporation Electric Supply Station, and it runs at 1,400 revolutions per minute. Current is brought into the room where the motor is fixed at a potential of 2,000 volts, and is then transformed down to 100 volts, in a 20-kilowatt Ferranti transformer, which is also used for street mains.

The lift from sea to the pump averages about 12 feet, and from the pump to the tank is about 42 feet, altogether with two inclines and four bends there is about 140 feet of four-inch cast-iron piping mostly in 9 foot lengths. From mid to full tide the tank can be filled in 140 minutes, which allowing an extra 10 feet for friction of pipe and bends gives

$$\frac{17{,}500 \times 10{\cdot}26 \times \overbrace{12 + 42 + 10}^{64}}{140 \times 33{,}000} = 2\tfrac{1}{2} \text{ H.P.}$$

From this it would appear that the motor is amply large for its work, and this brings us to the most remarkable feature of the installation, *i.e*, the number of pieces of apparatus that are required, and what is perhaps more important, the proportionately enormous amount of space which they occupy, to say nothing of the cost.

The motor (which it is only fair to say is very neatly designed), occupies a space of about 4 feet by 2 feet by 3 feet high. On the left is the Ferranti transformer which weighs about a ton and is about 3 feet by 1½ feet by 4 feet high. In the opposite corner is a water resistance for altering the phase in starting up, consisting of two earthenware tubes like drain pipes, with a pair of 9-inch diameter grooved pullies and hoisting gear, the whole being altogether about 2½ feet by 1 foot by 2½ feet high; and there is finally a throw over switch with a small transformer immediately below it and a resistance coil (4 inches diameter by 18 inches long), these occupying approximately 2 feet by 1½ feet by 1½ feet. When we come to consider therefore that all this apparatus is required to do 2½ horse-power in actual water lifted, there appears to be "something rotten in the state of Denmark," to put it very mildly.

Judging from the appearance of the installation, I should say that any firm in this country would put down a continuous current motor and starting switch and resistance to do the same amount of work which would occupy about about one-th'rd the space and cost less than half. It might perhaps be thought there is *great* saving of copper by bringing the current from the station at 2,000 volts, but a glance at the transformer is enough to disabuse anyone of that idea; any saving in the mains must be more than swallowed up in the transformer windings.

No fault can be found with the way the motor runs round, but when one is told that the 12 horse-power Oerlikon motor which was put down first, failed to do the work and had to be taken out, one begins to wonder if there is some unnatural law of inverse proportionality! governing single-phase motor work. I never yet heard of a continuous current motor that went wrong because it had too little work to do.

In conclusion, if a continuous current public supply had been available it would have been easy to make the motor fill the tank automatically, the current being put on and off by means of a switch attached to a water float. The apparatus installed, however, requires specially skilled attention, and by no manner of means could it be made to switch on automatically, for besides the water resistance and throw-over switch, there is the belt-striking gear to work each time.

Moral.—In a few years time, when the demand for motors has increased, what price single-phase alternating current supply from the consumer's point of view!

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

11,594A. "Application of electricity to the working of artillery." G. Martinez. Dated June 28th. (Date claimed under Patents, Rule 19, May 10th, 1897.)

15,379. "Improvements in the construction of electric rail and tramways." W. H. Burkitt. Dated June 28th.

15,396. "Improvements in or relating to carbons for electric welding, brazing, and like purposes." G. W. de Tunzelmann. Dated June 28th.

15,411. "Improved electric igniter for gas engines." R. Bosch. Dated June 28th. (*Complete.*)

15,419. "Improvements in or connected with electrical distribution fuseboards." Veritys, Ltd., and M. B. Cotterell. Dated June 29th.

15,472. "Improvement in electric furnaces." G. D. Burton. Dated June 29th. (*Complete.*)

15,484. "Improvements in means for electrically transmitting indication and alarms." J. J. Hicks and G. H. Zeal. Dated June 29th.

15,488. "Improvements in means or apparatus for charging accumulators." H. B. Cox and The Cox Thermo-Electric Co., Ltd. Dated June 29th. (*Complete.*)

15,490. "Improvements in electric heaters." G. B. Fraley. Dated June 29th. (*Complete.*)

15,491. "Improvements in electric heating apparatus." G. B. Fraley. Dated June 29th. (*Complete.*)

15,495. "Improvements in contact boxes for electric railways." W. M. Brown. Dated June 29th. (*Complete.*)

15,503. "Improvements in electric arc lamps." O. Imray. (The General Incandescent Arc Light Co., Ltd., United States.) Dated June 29th. (*Complete.*)

15,5.0. "Improvements in secondary or storage batteries or accumulators and in the manufacture of the same." J. Y. Johnson. (J. P. Clare, G. E. Hatch, and J. H. Taylor, United States.) Dated June 29th. (*Complete.*)

15,513. "Process for producing peat charcoal by means of an electrical current." C. A. Jensen. (P. Jebsen, Norway). Dated June 29th. (*Complete.*)

15,524. "Improvements relating to electric bell pushes, switches, and the like." C. D. Cibellas and A. Silvestri. Dated June 29th.

15,560. "Improvements in and relating to electrical bell pushes." M. Mercier. Dated June 30th.

15,603. "Improved electrical igniting apparatus for gas and petroleum engines." E. Delahaye. Dated June 30th.

15,607. "A method of effecting multiplex telegraphic and telephonic communication and apparatus for that purpose." J. Imray. (La Societe Anonyme pour la transmission de la force par l'electricite, France.) Dated June 30th.

15,609. "Improvements in electrical switches." J. W. Swan. Dated June 30th. (*Complete.*)

15,623. "Improved mouthpiece for telephones, speaking tubes and the like. K. Bolz. Dated June 30th.

15,656. "Improvements in screens used in connection with electric chronographs and other apparatus for ascertaining velocities." H. D. Wedlake and H. M. Fletcher. Dated July 1st.

15,712. "Improvements in electrical igniting gear for gas and oil engines." W. Baines and W. Norris. Dated July 1st.

15,721. "Improvements in electric arc lamps." R. Haddon. (The Patent Verwerthungs Gesellschaft, Germany.) Dated July Ist.

15,762. "The electric stage wedge." W. H. Whiteside. Dated July 2nd.

15,785. "Improvements in the form of the solid ends of stranded or other flexible electrical conductors." F. H. Somerville. Dated July 2nd.

15,830. "Fluids-dynamo-motor." M. Patrono. Dated July 3rd.

15,838. "Improvements in or appertaining to multiplex printing telegraph systems." P. M. Justice. (H. A. Rowland, United States.) Dated July 3rd.

15,850. "Improvements in certain apparatus to be employed in connection with the electro-deposition of metals." J. B. Brooks and J. Halt. Dated July 3rd.

15,870. "Improvements in the electrical propulsion of carriages and other vehicles, boats and the like." A. Müller and H. Tudor. Dated July 3rd.

15,876. "Improvements in writing telegraphs." P. A. Newton. (L. O. McPherson, United States.) Dated July 3rd. (*Complete.*)

15,877. "Improved system for feeding electricity to motor cars." L. Cerebotani and C. Marodelli. Dated July 3rd. (*Complete.*)

15,903. "Improvements in or connected with electric batteries." A. D. Seton and J. L. Dobell. Dated July 3rd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d. (in stamps).*]

1896.

1,249. "Improvements in synchronising mechanisms for alternating current generators." Dated January 17th, 1896. Relates to devices for synchronising the phase relation of alternating current dynamo-electric machines connected in parallel and its object is to accomplish this purpose by automatically regulating the engine or prime mover connected to the various machines. 3 claims.

2,249. "Improvements in and connected with fuses for electrical cut-outs." H. Hirst. Dated January 31st, 1896. The invention consists in inter-weaving or stitching a fusible metal with an insulating material in an irregular direction so as to prevent formation of an arc when the fuse is melted by an excess of current. 4 claims.

28,196. "Improvements relating to dynamo-electric machines, with motors for driving the same." A. Fischer and A. Held. Dated December 9th, Relates to a combined dynamo-electric machine with a pallet wheel or turbine serving as a motor for driving the same operated by water, compressed air, or steam. This driving wheel and the armature of the dynamo machine are situated on a common axle and form together a machine which can be connected to a pipe for supplying water under pressure, compressed air, or steam, and used for producing an electric current for illuminating purposes. The invention is especially adapted for domestic purposes. 3 claims.